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CORRECTIVE MEASURES STUDY ADDENDUM SOLID WASTE MANAGEMENT UNIT 7 AND 8 REVISED SOIL REMEDY WITH TRANSMITTAL AND RESPONSE TO COMMENTS NAVAL ACTIVITY PUERTO RICO

6/1/2012

AGVIQ/CH2M HILL

AGVIQ
ENVIRONMENTAL SERVICES
CH2M HILL
JOINT VENTURE

June 15, 2012

U.S. Environmental Protection Agency – Region II
290 Broadway – 22nd Floor
New York, New York 10007-1866

Attn: Mr. Phil Flax

RE: Contract No. N62470-08-D-1006
Task Order No. JM04
Solid Waste Management Units 7/8
Naval Activity Puerto Rico – Ceiba, Puerto Rico
Corrective Measures Study Addendum for SWMUs 7/8 – Revised Soil Remedy

Dear Mr. Flax:

AGVIQ-CH2M HILL Constructors Inc. Joint Venture III (AGVIQ-CH2M HILL), on behalf of the Navy, is pleased to provide one hard copy and one electronic copy provided on CD of the Corrective Measures Study Addendum for SWMUs 7/8 – Revised Soil Remedy at Naval Activity Puerto Rico. Additional distribution has been made as indicated below.

If you have any questions regarding this submittal, please contact Mr. Stacin Martin at (757) 322-4080.

Sincerely,

AGVIQ-CH2M HILL Constructors Inc. Joint Venture III

Tom Beisel, P.G.
Project Manager

cc: Ms. Debra Evans-Ripley/BRAC PMO SE (letter only)
Mr. David Criswell/BRAC PMO SE (letter only)
Mr. Tim Gordon/USEPA Region II (2 hard copies and 2 CDs)
Mr. Mark E. Davidson, BRAC PMO SE (1 hard copy and 1 CD)
Mr. Stacin Martin/NAVFAC Atlantic (1 hard copy and 1 CD)
Mr. Pedro Ruiz/NAPR (1 CD)
Mr. Carl Soderberg/USEPA Caribbean Office (1 hard copy and 1 CD)
Ms. Gloria Toro/PR EQB (1 hard copy and 1 CD)
Ms. Wilmarie Rivera/PR EQB (1 CD)
Ms. Connie Crossley/Booz Allen Hamilton (1 hard copy and 1 CD)
Ms. Bonnie Capito/NAVFAC LANTDIV (1 hard copy)
Ms. Lisamarie Carrubba/NMFS (1 CD)
Mr. Felix Lopez/U.S. Fish & Wildlife Service (1 CD)
Mr. Mark Kimes/Michael Baker Jr., Inc. (1 CD)

4610 Westgrove Court • Virginia Beach, Virginia 23455 • tel. (757) 318-9420 • fax (757) 318-9421
Northpark 400, 1000 Abernathy Road, Suite 1600 • Atlanta, Georgia 30328 • tel (770) 604-9095 • fax (770) 604-9282

Responses to EPA Comments Summary	
Regulatory Comments from:	Timothy R. Gordon (EPA Project Coordinator), Corrective Action and Special Projects Section, RCRA Programs Branch
Document:	*Corrective Measures Study Addendum – SWMUs 7 and 8 – Revised Soil Remedy,* Naval Activity Puerto Rico (NAPR), EPA ID PR2170027203, Ceiba, Puerto Rico, dated November 2011
Regulatory Letter Date:	March 08, 2012
Response Due Date:	June 18, 2012
Response Submittal Date:	June 18, 2012

EPA has completed its review of the CMS Addendum – Revised Soil Remedy and Statement of Basis – Proposed Final Soil Remedy, submitted by Mr. Tom Beisel's (of AGVIO/CH2MHill) letter of January 5, 2012, on behalf of the Navy. As part of that review EPA requested that our consultant, TechLaw Inc, also review the documents. TechLaw's comments are given in two Technical Reviews, dated February 29, 2012, which I had previously emailed to you on March 2, 2012.

Within sixty days of the date of your receipt of this letter, please submit a revised CMS Addendum for the surface and subsurface soils and a revised Statement of Basis, which address the above comments and those in the two Technical Reviews, dated February 29, 2012, which I had previously emailed to you on March 2, 2012. The revised documents should be dated with the actual date of submission to EPA, not some earlier date.

In addition, the Puerto Rico Environmental Quality Board (PREQB) in two letters dated January 23, 2012, both addressed to myself, indicated that they had no further comments on the CMS Addendum and the Statement of Basis on the Soil Remedy. I had previously emailed those letters to you on March 2, 2012.

EPA Comment:

A. Based on those reviews, EPA has determined that the corrective action objectives (CAOs) for soils utilized in the CMS Addendum are based on the CAOs developed in the November 2005 CMS Report prepared by Baker Environmental, Inc. Although the 2005 CMS was subsequently approved with conditions by EPA in February 2006, its CAOs were established using pre-2005 EPA Region 3 Risk-based Concentrations (RBCs). The Region 3 RBCs have been replaced for risk assessment screening purposes by the more recently-established EPA national Regional Screening Levels (RSLs).

Response:
As discussed during the conference call with EPA on April 17th, 2012, the existing CAOs have been revised using the latest toxicity factors and methodology available

from EPA RSL website, and the RSL calculator tool, as appropriate from the following location: http://www.epa.gov/region9/superfund/prg/. The revised soil CAOs for SWMUs 7/8 are detailed in new Section 1.4 *Revised Soil Corrective Action Objectives for SWMUs 7/8.*

B. The CAOs established in the 2005 CMS Report were predicated on now out-dated human health toxicity criteria and assessment methodologies. The most current, relevant EPA health-based screening criteria for initial screening purposes are the EPA Regional Screening Levels (RSLs), dating from November 2011. With respect to the polynuclear aromatic hydrocarbons (PAHs) at SWMUs 7/8, the residential CAO for soil developed in 2005 and now proposed in the CMS Addendum for PAH exposures is 0.088 mg/kg. The current PAH residential screening concentration based on the November 2011 RSLs is 0.015 mg/kg. This is a less than order-of-magnitude reduction from the RBC based 2005 CAO, translating to a less than order-of-magnitude increase in associated carcinogenic risk, based on a target risk of 1E-06 or an increase in allowable *in situ* risk of approximately 6E-06.

Likewise, based on the November 2011 RSLs, the industrial soil screening criteria for soils has been reduced from the 2005 CAO of 0.78 mg/kg to a concentration value of 0.21 mg/kg.

As noted in Section 3.1, site-wide risks associated with PAHs are expected to be low based on the fact that the original residential CAO of 0.088 mg/kg was not exceeded in any of the samples, even in the one duplicate sample where a low positive result was recorded.

The issue of utilizing the newer RSL screening criteria, versus the pre-2005 RBCs also impacts the background assessment of arsenic. The 2005 residential CAO is 2.65 mg/kg arsenic, while the November 2011 residential soil RSL is 0.39 mg/kg arsenic. Utilizing the RSL for arsenic results in a near order-of-magnitude increase in the associated risk for residual exposure to arsenic concentrations of 2.65 mg/kg that would be left in the soil based on the 2005 CAO.

The conclusion in Section 4.2 of the CMS Addendum that "no institutional controls will be recommended for site soils/surface media at SWMUs 7/8" is not acceptable. In addition to EPA's above described concerns with the continued usage of the 2005 CAOs for PAHs and arsenic based on pre-2005 Region 3 risk-based concentrations (RBCs), rather than the more protective 2011 RSLs, EPA also notes the following additional factors that warrant institutional controls being placed on the site for surface and subsurface soils:

- Section 1.1 of the CMS Addendum indicates that nine underground storage tanks (USTs), used for the storage of marine diesel fuel, jet fuel (JP-5) and Bunker C fuel, were located throughout SWMU 7/8. Two of the tanks were removed in 1996, which also required the removal of 329 tons of contaminated soils. In March 2004, fuel storage and distribution operations were discontinued and the remaining seven USTs and associated piping were drained and are empty. The section goes on to

state that "During the facility's operational history, numerous releases have occurred from the USTs and associated pipelines." Based on the presence of existing USTs and piping, and known releases during the operational history of the unit, it would appear that institutional controls should be placed on this property to control future excavation activities, as any future residential or commercial/industrial development including excavation/construction would result in the need to remove and possibly remediate USTs and associated piping. In fact, several 0 to 2 foot soil samples could not be collected during the 2009 sampling event due to the presence of tanks or piping in the shallow subsurface which indicates that the tanks/piping would be encountered even in shallow excavations.

- EPA's February 2006 approval of the November 2005 CMS Report (contained in Appendix D of the CMS Addendum) stated "Specifically, this proposed Corrective Measure/final remedy includes: ... placement of land use controls/institutional controls over the areas impacted by releases from Tow Way Fuel Farm (SWMU 7 and 8). Such land use controls/institutional controls would include: 1) prohibition of development of buildings on the site that may be occupied by humans ..." It should be noted that this prohibition on the development of residential buildings was included along with a requirement to excavate surficial soils exceeding the CAOs of 2.65 mg/kg arsenic and PAH concentrations of 0.78 mg/kg. Based on the above discussed recommended usage of the newer RSLs to set CAOs, instead of the pre-2005 RBCs, EPA considers the need for institutional controls to prevent future residential usage to still be warranted.

Therefore, EPA request that the CMS Addendum be revised to include specific institutional controls, as discussed above, that "run-with-the land" (i.e., will remain applicable to future owners) so as to prevent future residential usage, unless additional corrective measures are implemented which allow future unrestricted/residential usage.

Any changes in the approach as outlined in the CMS Addendum with respect to the PAHs and arsenic will need to be applied in the Statement of Basis.

Response:

A description of existing LUCs that will be maintained during remedial actions is detailed in new Section 1.5 *Land Use Controls at SWMUs 7/8* of the Soil CMS Addendum. In addition, a summary of the LUCs to be included in the deed if the parcel were to be transferred is also included in this section.

Section 3.3 *Land Use and Institutional Controls for Site Soils* has been removed from the document, as LUCs were addressed earlier in Section 1.5.

As recommended in the TechLaw Comment 1 (Section: TechLaw Additional Comments), the third paragraph in Section 4.2 has been modified to recommend LUCs for SWMUs 7/8.

Changes to the CMS Addendum based on EPA and TechLaw comments with respect to PAHs and arsenic have been applied to the Statement of Basis.

Responses to TechLaw Comments Summary	
Regulatory Comments from:	Cathy Dare (TechLaw, Inc.)
Document:	*Corrective Measures Study Addendum – SWMUs 7 and 8 – Revised Soil Remedy,* Naval Activity Puerto Rico (NAPR), EPA ID PR2170027203, Ceiba, Puerto Rico, dated November 2011
Regulatory Letter Date:	February 29, 2012 (Date provided on TechLaw technical review document)
Response Due Date:	June 18, 2012
Response Submittal Date:	June 18, 2012

The following comments were generated based on an evaluation of the November 29, 2011, Navy Response to EPA Comments dated October 18, 2011 on the *Corrective Measures Study Addendum – SWMUs 7 and 8 – Revised Soil Remedy* (CMS Addendum), Naval Activity Puerto Rico, EPA ID PR2170027203, Ceiba, Puerto Rico (hereinafter referred to as the RTCs). Only those comments which were not adequately addressed are presented below. TechLaw also reviewed the responses to determine whether they were incorporated into the CMS Addendum dated November 2011. Additional comments on the November 2011 CMS Addendum are presented below after the evaluation of the RTCs.

Evaluation of Response to EPA Comments:

Evaluation of Response to EPA General Comment 2: The response is not adequate. Please see Additional Comment 1 below.

Response:
Please see below for responses.

Evaluation of Response to EPA General Comment 3: The response is not adequate. Please see Additional Comment 1 below.

Response:
Please see below for responses.

Evaluation of Response to TechLaw Comments:

Evaluation of Response to TechLaw General Comment 2: The response is not adequate. It is unclear how the historical background data is applicable to SWMU 7/8. Neither the response nor the CMS Addendum specify at what depths background samples were collected. Revise the

CMS Addendum to specify at what depths the background samples were collected, and discuss how any differences in sample depths between that of the investigation and background samples affects background comparisons in the CMS Addendum.

Response:
The background study report was prepared to establish inorganic chemical ambient levels for comparison against those detected in site soil samples for all sites within the NAPR facility, including for use at SWMUs 7/8, as described in the "Purpose of Report" section on Page 1-1 of the background study report, *Revised Final Summary Report for Environmental Background Concentrations of Inorganic Compounds. October 17 (Baker. 2006).*

As indicated in this background report, the background sample locations were selected from the un-impacted areas of the Island, including samples near the SWMUs 7/8 area with representative soil types. As included in Figures 2-2 (soil types), and in Figures 3-1, 3-2, and 3-3 of the background study report, some of the background study soil samples are located in the un-impacted areas near SWMUs 7/8. The soil boring logs for the background study were included in Appendix C of the background study report referenced above. As indicated in the background study report, soil types are similar between SWMUs 7/8 soil samples and some of the background soil samples. In addition, the established background levels were also intended for use at SWMUs 7/8. The surface soil samples were collected from 0- to 2-foot depths (see Appendix C), similar to the sampling depths at the SWMUs 7/8 collected for the CMS and CMS Addendum investigations. Since the background report clearly identified the sample depths and the purpose of the sampling, no additional changes will be made to SWMUs 7/8 CMS Addendum report.

Evaluation of Response to TechLaw General Comment 2 (continued): In addition, the response states that the majority of samples collected as part of the post-CMS investigation consisted of silt and sand; however, review of the soil descriptions provided in Table 2-1, Pre-Excavation Soil Delineation Sample Summary at SWMU 7/8 (June 2009), indicates that the majority of samples consisted of silty-clay and clayey soils. It is noted that the response states that background subsurface clays had an estimated upper tolerance limit (UTL) value less than that of background subsurface sand/silts (1.95 mg/kg versus 6.66 mg/kg). Revise the CMS Addendum to discuss if and how this impacts the comparison of investigation data with that of background data, and any associated conclusions drawn.

Response:
The soil types described in Table 2-1 are correct, and they consist of silty-clay, clay, and silts, etc., as described in the table for each boring. The established surface soil arsenic from the background study of 2.65 mg/kg was used for comparison with site surface soil concentration levels as presented in Sections 3.2 and 4.2 of the CMS Addendum report. Therefore, the CMS Addendum report does not require any revisions because no corrections are identified as a result of this comment.

Evaluation of Response to TechLaw General Comment 2 (continued): Finally, review of Table 3-4, Descriptive Statistics – Subsurface Soil Background, Clay, of the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds*, dated February 29, 2008, indicates that the UTL value for arsenic in surface soil is 2.65 mg/kg rather than

3.65 mg/kg; and, that the UTL value for arsenic in subsurface clay is 1.59 mg/kg rather than 1.95 mg/kg. Revise the CMS Addendum as necessary to address these discrepancies, and revise any comparisons of investigation data to background data as necessary.

Response:
Agree with the comment. The response misquoted the arsenic background level as 3.65 mg/kg for surface soil and 1.95 mg/kg for subsurface soil, in place of actual values, 2.65 mg/kg and 1.59 mg/kg, respectively. However, all sections of the CMS Addendum report used the CAO of 2.65 mg/kg for surface soil that is based on the established surface soil arsenic background levels for the base. Since these misquoted numbers were limited to comment responses, the CMS Addendum report does not require any revisions.

Evaluation of Response to TechLaw Specific Comment 2: The response is adequate; however, the text of the CMS Addendum has not been revised to reflect the response. Revise the CMS Addendum as indicated in the response.

Response:
The second paragraph in Section 1.3 of the CMS Addendum report has been modified as follows:

The regulatory-approved remedial action to address soil contamination at SWMUs 7/8 includes the excavation of the upper 2 feet of soil in three areas of concern for locations where the PAH compounds benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, and arsenic exceeded their respective CAOs (Baker, 2005). The Final CMS report, approved by EPA, identified industrial land use based CAOs of 2.9 mg/kg, and a construction worker protection based target CAO of 7.3 mg/kg for benzo(a)pyrene. The toxicity equivalence factor (TEF) for benzo(a)anthracene, benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene is 0.1 per EPA guidance for PAH evaluations (i.e., these chemicals are tenfold less toxic than benzo(a)pyrene [TEF = 0.1]). The term, "total soil," refers to combined soil data for surface and subsurface soil up to a depth of 10 feet. Baker developed the CAOs using an industrial land use based exposure scenario involving exposure to surface soil, and a construction worker exposure scenario for contact with total soil, which is combined surface and subsurface soil. The 2005 Final CMS based soil CAOs for the contaminants of concern are presented in Table 1-1.

TechLaw Additional Comments:

1. The conclusion in Section 4.2 of the CMS Addendum is "no institutional controls will be recommended for site soils / surface media at SWMUs 7/8." However, the CMS Addendum does not fully support this approach. The following issues lead to the conclusion that institutional controls should be placed on the property for surface and subsurface soils:

   Response:
   The third paragraph in Section 4.2 will be modified as follows to briefly discuss existing LUCs for SWMUs 7/8 as detailed in new Section 1.5.

As presented in Section 1.5, existing LUCs are included as part of the corrective action to prevent the unintended exposure to groundwater. Existing LUCs are described in the Quitclaim Deed for CDR Parcel 2 signed by the Navy and the LRA on December 20, 2011. Current LUCs, including restricted access to the SWMUs 7/8 area through security fencing, will be maintained until the CAOs are achieved. The LUCs will be included in any lease or transfer deed. If development other than industrial use (i.e., residential or per the April 2010 amended Reuse Plan) is proposed, the new owner will be required to work with the PREQB and EPA to establish any additional investigation, risk assessment, and/or cleanup activities. If the property owner wishes to remove the LUC on the groundwater from the deed in the future, it will be the responsibility of the property owner to demonstrate the groundwater meets all state and federal MCLs, and must obtain approval from the Navy, EPA, and PREQB prior to LUC removal.

- Section 1.1 indicates that nine underground storage tanks (USTs), used for the storage of marine diesel fuel, jet fuel (JP-5) and Bunker C fuel, were located throughout SWMUs 7/8. Two of the tanks were removed in 1996, which also required the removal of 329 tons of contaminated soils. In March 2004, fuel storage and distribution operations were discontinued and the remaining seven USTs and associated piping were drained and are empty. The section goes on to state that "During the facility's operational history, numerous releases have occurred from the USTs and associated pipelines." Based on the presence of existing USTs and piping, and known releases during the operational history of the unit, it would appear that institutional controls should be placed on this property to control future excavation activities, as any future residential or commercial/industrial development including excavation/construction would result in the need to remove and possibly remediate USTs and associated piping. In fact, several 0 to 2 foot soil samples could not be collected during the 2009 sampling event due to the presence of tanks or piping in the shallow subsurface which indicates that the tanks/piping would be encountered even in shallow excavations.

Response:
As indicated above, LUCs will be maintained for the site because of the continued presence of groundwater contamination at SWMUs 7/8.

EPA's approval of the November 2005 CMS Report (contained in Appendix D of the CMS Addendum) states "Specifically, this proposed Corrective Measure/final remedy includes: … placement of land use controls/institutional controls over the areas impacted by releases from Tow Way Fuel Farm (SWMU 7 and 8). Such land use controls/institutional controls would include: 1) prohibition of development of buildings on the site that may be occupied by humans …." It should be noted that this prohibition on the development of buildings was included *along with* the requirement to excavate the surficial soils.

Response:
Comment noted. Please refer to the first response of this comment. Section 1.5 has been added to the Soil CMS Addendum to provide detailed information concerning the LUCs for SWMU 7/8.

- Table 3-1 indicates the Method Detection Limits (MDLs) and reporting limits (RLs) are above the RBCs for residential (unrestricted) use. The second bullet item on Page 3-2 of the CMS Addendum explains that the reported MDLs and RLs are five times higher than the actual instrument detection limits, and when corrected for the dilution factor, the instrument detection limits are within the range of the RBC value (0.088 mg/kg). However, unless the samples were analyzed without dilutions and MDLs are available to be reported in that condition, the MDLs and RLs from the diluted samples must be used for decision making purposes. Thus, the MDLs and RLs are above the residential RBC for benzo(a)pyrene.

  Response:
  Agree with the comment that dilution factor based MDLs are above residential RBCs. However, given the large number of samples collected and analyzed for PAHs, and with the exception of one sample with low level, none of the other samples had PAHs at detectable levels. Overall, it is concluded that, while analytical detection limits are elevated, the historically detected levels shown on Figure 1-8 of the 2005 CMS are no longer remaining at the site. Based on the data from all samples and one low level detection at one location in sample A22 (see CMS Addendum, Figure 3-1), the U.S. Navy believes that surface soils at SWMUs 7/8 no longer have PAHs at levels that are an exposure concern for receptors.

- Section 2.2 states "the collection of soil samples from 0-2 feet bgs was designed to support the *excavation decisions*. The sampling depth was considered appropriate because the original PAHs in surface soils were well above the CAO of 7.3 mg/kg and collecting surface soil samples from 0-2 feet bgs instead of the original 0-1 foot bgs affords a potential dilution factor of 2 through mixing." Section 3.1 of the CMS Addendum discusses that PAHs may be degrading on-site and that is a potential reason for the differences between the original RFI samples and the 2009 CMS data. However, another potential scenario is that PAHs were a result of surficial releases and are bound in the upper one foot of soil. Thus, the 0-2 foot below ground surface (bgs) samples collected in 2009 resulted in diluted concentrations of PAHs.

  Response:
  The Final CMS report (Baker, 2003) contained individual soil samples collected between 1996 and 2002 and their sampling depths are included in Table 3-2. The surface soil samples collected ranged from 0- to 1-foot to 0- to 4-foot depths. The three samples that had highest PAHs were collected from 1 to 2 feet bgs. Thus, the assumption in this comment that the current results from samples collected from 0 to 2 feet were due to possible dilution is not supported by the actual sample depths of the historical data.

Based on all of this information, the CMS Addendum and Statement of Basis should be revised to include land use controls/institutional controls that prohibit residential development on the property comprising SWMUs 7/8. Controls on excavations associated with commercial/industrial development should also be considered due to the presence of the USTs and piping.

Response:
Please refer to the first response of this comment. A description of existing LUCs that will be maintained during remedial actions is detailed in new Section 1.5 *Land Use Controls at SWMUs 7/8* of the Soil CMS Addendum. In addition, a summary of the LUCs to be included in the deed if the parcel were to be transferred is also included in this section.

Section 3.3 Land Use and Institutional Controls for Site Soils has been removed from the document, as LUCs were addressed earlier in Section 1.5.

The third paragraph in Section 4.2 has also been modified pertaining to LUCs.

2. The table of contents and the fifth bullet on Page 3-4 reference a Table 3-2, Data Summary for Areas A, B, and C at SWMU 7/8. No Table 3-2 has been provided. Revise the CMS Addendum to provide this table.

Response:
Table 3-2 has been added to the revised CMS Addendum report.

3. Section 3.1, PAHs, indicates that only benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-c,d)pyrene among the B2 PAHs were selected as constituents of concern (COCs). Please note that if any B2 carcinogenic PAH is selected as a site COC, then all associated, detected B2 carcinogenic PAHs must be retained under the same status. This is because these constituents are reduced to benzo(a)pyrene equivalents (BaP_{eqv}), based on relative potency to BaP and should not be screened or assessed from a risk assessment perspective individually.

On a similar, related topic, this same section describes BaP_{eqv} as being assessed based on the toxicity equivalency factor (TEF). Please note that the B2 carcinogenic PAHs do not meet all the criteria required of application of the TEF, consistent with the paradigm used to assess 2,3,7,8-substituted dibenzo-*p*-dioxins and furans. Instead, BaP_{eqv} is assessed based on a relative potency factor (RPF) approach consistent with the USEPA's *Provisional Guidance for the Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (1993) and supplemental guidance.

Response:
Comment noted for future projects involving PAHs. No BaP_{eqv} were estimated for soil PAHs related decisions at SWMUs 7/8. PAHs selected for this CMS Addendum are those identified as COCs in the 2005 CMS approved by EPA Region 2. Since each of the PAH COCs were addressed individually in the CMS Addendum, and the final decisions are not based on BaP_{eqv}, any potential for under estimation as indicated in the comment for individual PAH contributions is not a concern for SWMUs 7/8. However, at this stage of project involving remedial decisions, COCs were focus of the remedial action and all non-COCs were not included.

Comment noted on terminology for relative toxicity factors. Currently, several State agencies (e.g., Florida and Washington), some regional EPA guidance documents (e.g.,

EPA Region 4), and other entities use TEFs and RPFs synonymously. The comment will be considered for future risk evaluations at NAPR.

Corrective Measures Study Addendum
SWMUs 7 and 8 – Revised Soil Remedy

Tow Way Fuel Farm Area
Naval Activity Puerto Rico
Ceiba, Puerto Rico

Revision No. 00

Contract No. N62470-08-D-1006
Task Order No. JM04

Submitted to:

NAVFAC
Naval Facilities Engineering Command

U.S. Naval Facilities
Engineering Command
Southeast

Prepared by:

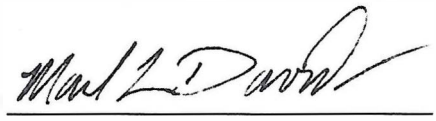
AGVIQ
ENVIRONMENTAL SERVICES
CH2M HILL
JOINT VENTURE

1000 Abernathy Road
Suite 1600
Atlanta, GA 30328

June 2012

Certification Page for Corrective Measures Study Addendum (Revision No. 00) SWMUs 7 and 8 – Revised Soil Study

I certify under penalty of law that I have examined and am familiar with the information submitted in this document and all attachments and that this document and its attachments were prepared either by me personally or under my direction or supervision in a manner designed to ensure that qualified and knowledgeable personnel properly gather and present the information contained therein. I further certify, based on my personal knowledge or on my inquiry of those individuals immediately responsible for obtaining the information, that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowingly and willfully submitting a materially false statement.

Signature: 

Name: Mark E. Davidson

Title: BRAC Environmental Coordinator

Date: June 15, 2012

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Acronyms and Abbreviations

AGVIQ-CH2M HILL	AGVIQ-CH2M HILL Joint Venture III
Baker	Baker Environmental, Inc.
BEQ	benzo(a)pyrene equivalent
bgs	below ground surface
BRAC	Base Realignment and Closure
CAO	Corrective Action Objective
CMS	Corrective Measures Study
DPT	direct-push technology
EPA	U.S. Environmental Protection Agency
IC	institutional control
LRA	Puerto Rico Local Reuse Authority
LUC	land use control
mg/kg	milligrams per kilogram
NAPR	Naval Activity Puerto Rico
NFA	no further action
PAH	polynuclear aromatic hydrocarbon
QA	quality assurance
QC	quality control
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
SWMU	solid waste management unit
TEF	toxicity equivalency factor
TWFF	Tow Way Fuel Farm
UCL95%	upper-bound confidence limits at 95 percent
UFP-SAP	Uniform Federal Policy - Sampling and Analysis Plan
WRS	Wilcoxon Ran Sum

1.0 Site and Project Introduction

AGVIQ-CH2M HILL Constructors, Inc. Joint Venture III (AGVIQ-CH2M HILL) was contracted by the Department of the Navy, Naval Facilities Engineering Command Southeast, under Contract No. N62470-08-D-1006, Task Order JM04, to implement corrective measures at solid waste management units (SWMUs) 7 and 8 located at the Tow Way Fuel Farm (TWFF), Naval Activity Puerto Rico (NAPR), Ceiba, Puerto Rico. This Corrective Measures Study (CMS) Addendum describes the soil sampling procedures and results of the soil delineation activities performed between January 22, 2009, and July 15, 2009. Sampling was performed in three areas of the site where the polynuclear aromatic hydrocarbon (PAH) compounds benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, and the element arsenic exceeded the corrective action objectives (CAOs) established in the CMS prepared by Baker Environmental, Inc. (Baker) in November 2005. Excavation of the upper 2-feet of soil was proposed in the CMS to remove the contamination from three areas of concern. The U.S. Environmental Protection Agency (EPA) approved the CMS for implementation in February 2006. During the review of this draft CMS Addendum report, EPA requested that the CAOs be updated to represent the latest EPA approaches to developing risk-based target levels and use the newly developed CAOs as the target levels for corrective actions.

The objectives of the sampling were to:

- Refine the limits of excavation because the three areas of concern as presented in the CMS report (Baker, 2005) were based on the extrapolation of a limited set of soil analytical data.
- Determine the current concentrations of the PAH compounds benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene in the surface soil because the possibility exists that concentrations may have decreased through natural degradation and are now below the revised industrial CAOs.
- Determine if arsenic concentrations in the upper 2 feet of soil fall within the range of background concentrations for the island of Puerto Rico, and/or are present at concentrations that are statistically below the CAO. If so, the area of arsenic contamination requiring excavation may be smaller in size or may not be required.

In order to meet these objectives, the following tasks were performed:

- Marked the locations of the soil delineation sampling points by establishing grids over the three areas of concern targeted for excavation in the CMS. Collocated samples were collected from previous high concentration sample locations.
- Collected soil samples from the upper 2-feet of soil using a direct-push technology (DPT) drill rig. In areas were a DPT drill rig could not be used due to steep changes in topography or because of physical obstructions, samples were collected using a hand auger.

- Submitted soil samples from 18 borings for the analysis of the PAH compounds benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene using EPA Method 8270C.
- Submitted soil samples from 72 borings for the analysis of arsenic using EPA Method 6010B.
- Grouted the holes upon completion.
- Retained the services of a professionally licensed land surveyor to survey the horizontal locations and vertical elevations of the boreholes relative to previously established benchmarks.

The CMS Addendum is organized as follows:

- Site and Project Introduction (Site History)
- Summary of Field Investigation Procedures
- Discussion of Results
- Findings and Recommendations

1.1 Site History

The NAPR occupies over 8,600 acres at the northeastern-most portion of Puerto Rico along the Vieques Passage (Figure 1-1). The northern entrance to NAPR is about 35 miles east, along the coastal road (Route 53) from San Juan. The facility was commissioned in 1943 as a Naval Operations Base but was re-designated in 1957 as a Naval Station.

The TWFF is located on a hillside along Forrestal Drive north of Ensenada Honda. The fuel farm was constructed prior to 1957 and originally consisted of nine bomb-proof underground storage tanks (USTs) (Figure 1-2). The tanks were used for the storage of marine diesel fuel, jet fuel (JP-5), and Bunker C fuel. Closure of Tanks 56A and 56B was completed in November 1996 by Reliable Mechanical, Inc. Two 10,000-gallon steel tanks and 329 tons of contaminated soil were bioremediated and disposed of as non-regulated waste. In addition to the nine bomb-proof USTs, two USTs (470 and 471) used for the storage of leaded gasoline and high-octane aviation gasoline (AVGAS) were located south of existing Tank 1088. The leaded gasoline and AVGAS tanks previously were removed; however, details regarding their removal are unknown.

On March 31, 2004, NAPR operations, including the storage and distribution of fuel, were discontinued. The seven remaining USTs (82, 83, 84, 85, 1080, 1082, and 1088) and associated piping were drained and are empty. During the facility's operational history, numerous releases have occurred from the USTs and associated pipelines.

1.2 Regulatory History

The U.S. Environmental Protection Agency (EPA) Region 2 is the primary agency that regulates environmental activities at the NAPR, and site work is performed under the January 29, 2007 Resource Conservation and Recovery Act (RCRA) Administrative Order on Consent (AOC) - 7003. In addition, the Puerto Rico Environmental Quality Board (PREQB)

provides regulatory input. The EPA has assigned the following SWMU designations to the TWFF:

- SWMU 7 – Encompasses environmental impacts from releases that emanated from the nine USTs (currently seven) located on a hillside along Forrestal Road north of Ensenada Honda.
- SWMU 8 – Encompasses TWFF sludge disposal; however, previous investigations were unable to locate evidence of the pits, and the EPA combined SMWU 8 with SWMU 7.

1.3 Summary of Previous Work

Between 1982 and 2005, numerous investigations and remedial tests were performed to determine the extent of petroleum hydrocarbons in the soil and groundwater beneath the TWFF. An RCRA facility investigation (RFI) report was prepared in 1997, and in this RFI, the analytical data for the samples collected were compared against both industrial and residential risk-based concentrations (RBCs), and a risk assessment was conducted for site soils and groundwater under both industrial and residential land use scenarios (RFI, 1997). The results of the previous work were summarized in a CMS report prepared by Baker (2005). The CMS report included a discussion of contaminant extent in soil and groundwater, LNAPL distribution, the hydraulic and physical properties of the soil and groundwater, pilot test results, and studies performed to formulate remedial strategies for cleanup of the soil and groundwater to risk-based CAOs. The use of LNAPL-only recovery pumps was proposed for the removal of LNAPLs, and monitored natural attenuation (MNA) was proposed to reduce concentrations of select volatile organic compounds (VOCs) to the CAOs. Soil excavation of the upper 2 feet of soil within the fuel farm area was proposed to remove select polycyclic aromatic hydrocarbon (PAH) compounds and arsenic that exceeded the risk-based CAOs. The EPA approved the CMS on February 9, 2006 (Appendix D).

The regulatory-approved remedial action to address soil contamination at SWMUs 7/8 includes the excavation of the upper 2 feet of soil in three areas of concern for locations where the PAH compounds benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, and arsenic exceeded their respective CAOs (Baker, 2005). The Final CMS report, approved by EPA, identified industrial land use based CAOs of 2.9 mg/kg, and a construction worker protection based target CAO of 7.3 mg/kg for benzo(a)pyrene. The toxicity equivalence factor (TEF) for benzo(a)anthracene, benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene is 0.1 per EPA guidance for PAH evaluations (i.e., these chemicals are tenfold less toxic than benzo(a)pyrene [TEF = 0.1]). The term, "total soil," refers to combined soil data for surface and subsurface soil up to a depth of 10 feet. Baker developed the CAOs using an industrial land use based exposure scenario involving exposure to surface soil, and a construction worker exposure scenario for contact with total soil, which is combined surface and subsurface soil. The 2005 Final CMS based soil CAOs for the contaminants of concern are presented in Table 1-1.

Figures 1-3 through 1-7 illustrate areas where the CMS report (Baker, 2005) identified surface soil arsenic, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene) concentration levels that exceeded the CAOs. These figures were

obtained from the EPA-approved Final CMS report (Baker, 2005). The data presented in the CMS indicated that the vertical extent of soil contamination above the CAOs was limited to the upper 2 feet of soil. Using the Natural Neighbor interpolation approach of the computer model GMS v5.1, Baker estimated the areal extent of contamination requiring excavation through the extrapolation of a limited set of soil analytical data. The three areas of concern requiring excavation based on Baker's modeling effort are shown on Figure 1-8.

Because the areas requiring excavation were based on modeling results, AGVIQ-CH2M HILL prepared a Uniform Federal Policy-Sampling and Analysis Plan (UFP-SAP) and Work Plan to perform a pre-excavation delineation of SWMUs 7/8 to verify the limits of excavation described in the CMS, and to determine if arsenic is naturally occurring or is a result of past practices used by the Navy (AGVIQ-CH2M HILL, 2009). The UFP-SAP and Work Plan were submitted to the Navy during the first quarter of 2009 and approved for implementation in April 2009.

TABLE 1-1
Soil CAOs for Various Land Use Scenarios from Final CMS Report

Chemical	Maximum Observed Concentration	Surface Soil CAO*	Subsurface Soil CAO*	Total Soil CAO**	Soil CAO***
Arsenic	3.4	2.65	NA	NA	NA
Benzo(a)anthracene	6J	29	NA	73	0.88
Benzo(a)pyrene	23J	2.9	7.3	7.3	0.088
Benzo(b)fluoranthene	5.9J	29	NA	73	0.88
Indeno(1,2,3-cd)pyrene	5.3J	29	NA	73	0.88

CAO Corrective Action Objective from Final CMS report (Baker, 2005)
* Based on industrial worker protection
** Based on construction worker protection
*** Residential Land use based target levels – Not in Final CMS, added here based on 2005 Region 3 RBC Table
J Estimated
NA Not Applicable
All values reported in milligrams per kilogram (mg/kg).
Section 3.1 includes a comparison of latest soil data against the CAOs identified in this table.

1.4 Revised Soil Corrective Action Objectives for SWMUs 7/8

During CMS Addendum report review, EPA requested that the CAOs for SWMUs 7/8 shown in Table 1-1 from the 2005 CMS report be revised in accordance with current EPA practices using the latest calculation methods and toxicity factors (EPA Regional Screening Levels [RSL], updated November 2011) as listed at website: http://www.epa.gov/region9/superfund/prg/. The revised CAOs were calculated for industrial (indoor) worker and construction worker scenarios. Therefore, the CAOs for SWMU 7/8 were revised using the methods or calculator tool provided in the online resources by the EPA RSLs (EPA, 2011), and EPA's latest version of the J-E Model groundwater spreadsheet from its online web site (EPA, 2012). The technical memorandum *Revised Corrective Action Objectives for Solid Waste Management Units 7&8, 54, and 55* provides

details for the revised CAOs for surface soil, total soil (surface soil and subsurface soil, combined), and groundwater for SWMUs 7/8 (Appendix F). Revised soil CAOs for the contaminants of concern are presented in Table 1-2.

TABLE 1-2

Soil COCs and Revised CAOs - June 2012

COCs[1]	2009-Maximum Observed Concentration in Soil[1,5] (mg/kg)	Surface Soil Industrial Worker (mg/kg) Revised CAOs[2]	Total Soil Construction Worker (mg/kg) Revised CAOs[2]	Soil Residential (mg/kg) RSLs - November 2011[3]	Soil Industrial CAOs mg/kg May-2012[6]
Metals					
Arsenic	4.3	3.81	55	0.39	3.81
Semivolatiles					
Benz(a)anthracene	ND (<0.13 - <2.4)	7.8	73	0.15	7.8
Benzo(a)Pyrene	ND (<0.13 - <2.4)	7.8 [(4)]	7.3	0.015	7.3
Benzo(b)fluoranthene	ND (<0.13 - <2.4)	7.8	73	0.15	7.8
Indeno-1,2,3-cd-pyrene	ND (<0.13 - <2.4)	7.8	73	0.15	7.8

Notes:

1. Arsenic occurs in background soils, and background arsenic value for surface soil is 2.65 mg/kg. Site maximum is based on 72 samples, and highest UCL is 2.5 mg/kg.
2. EPA RSLs calculated using November 2011 from the following web link. See Attachment B.

http://www.epa.gov/region9/superfund/prg/

3. EPA Regional Screening Table, November, 2011.
4. For Benzo(a)pyrene, CAO for industrial worker is based on a target risk of 1×10^{-5}, construction worker CAO and residential RSL is based on a target risk of 1×10^{-6}.
5. The PAH concentrations were below detection limits (DL) in all samples. DLs ranged between 0.13 mg/kg to 2.4 mg/kg for individual PAH constituents (see CMS Addendum, Table 3-1).
6. Proposed industrial CAOs are lower of the industrial worker and construction worker based CAOs.

CAO = corrective action objective

COC = contaminant of concern

ND - Non-detect

mg/kg = milligrams per kilogram

1.5 Land Use Controls at SWMUs 7/8

SWMUs 7/8 are currently under industrial land use. The Navy plans to maintain this site under the industrial land use into the future even when there is a property transfer to a new owner. Land use controls (LUCs) are recommended at SWMUs 7/8 because of the presence of buried USTs and associated pipelines that have been closed and abandoned in-place. Additionally, site soils corrective actions are designed to achieve industrial CAOs, and thus are not remediated for unrestricted land use. The ecological risk evaluation concluded that there are no significant risks to ecological receptors from the soils at SWMU 7/8. Therefore, to protect human health under unrestricted land use scenario in the future if the site is developed for residential construction, LUCs are recommended, which consist of engineering and/or institutional controls.

Existing LUCs are included as part of the corrective action to prevent development of the site for residential or other non-industrial uses. Existing LUCs are described in the Quitclaim Deed for CDR Parcel 2 signed by the Navy and the Puerto Rico Local Reuse Authority (LRA) on December 20, 2011 and apply to both, soils and groundwater at SWMU 7/8. Current LUCs, including restricted access to the SWMUs 7/8 area through security fencing, will be maintained under current industrial land use. When remedial actions are complete at SWMU 7/8, LUCs must be maintained, including:

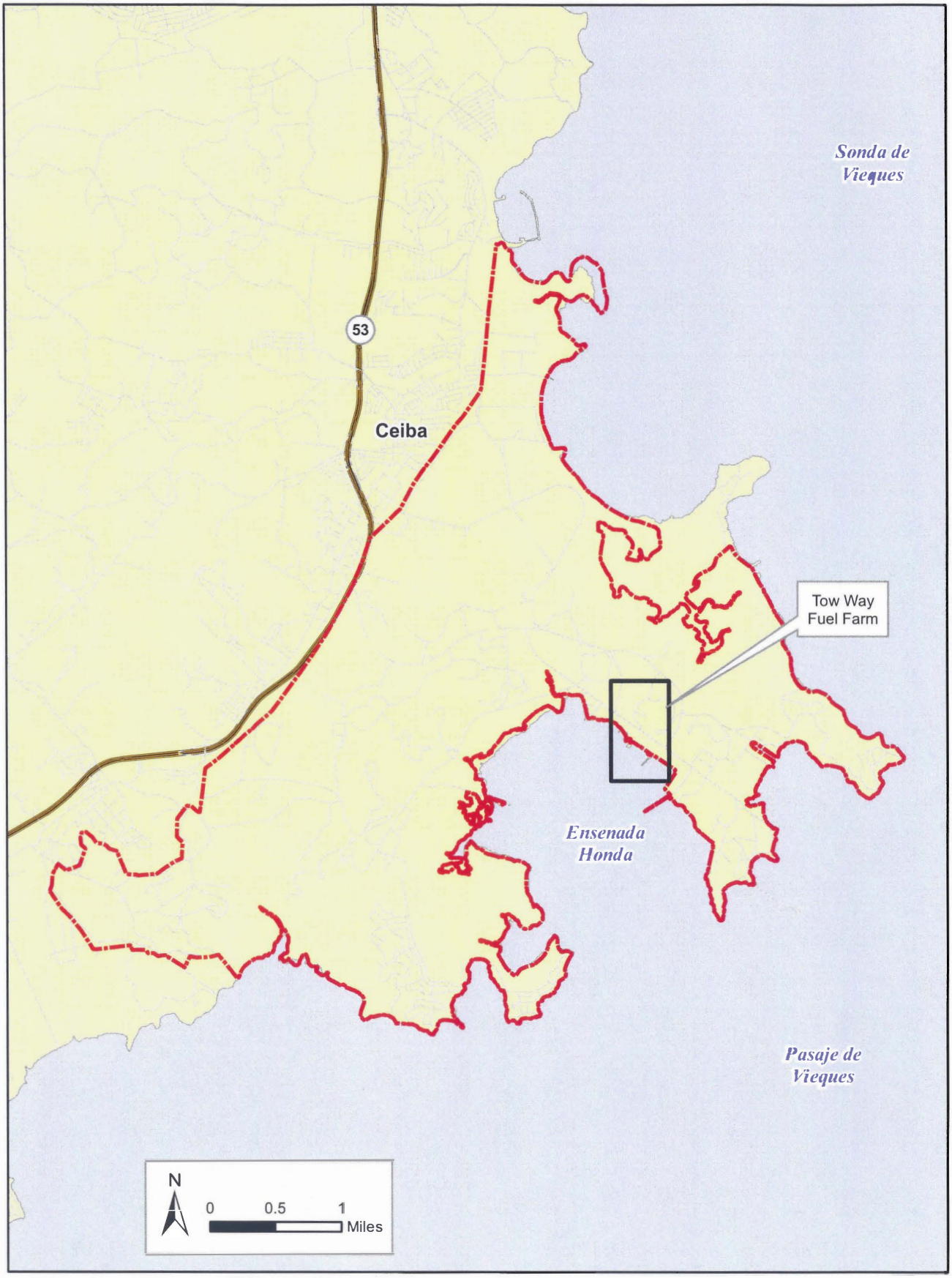
- No permanent residences may be installed on the property.
- No groundwater extraction wells may be installed by the deed grantee.
- Potential for vapor intrusion must be considered by the developer and addressed by the developer, as needed.
- The grantee may not interfere with any existing or future groundwater remedial systems.
- The grantee must complete annual inspections of the property to ensure all LUCs are being complied with and provide written certification of the inspection.
- The grantee must comply with the RCRA Administrative Order on Consent for this property (provided to the LRA by the U.S. Navy).
- Release of environmental conditions and grantee covenants can be considered only with EPA concurrence.
- In order to develop, improve, use, or maintain the property in a manner inconsistent with the LUCs, the grantee must submit a written request seeking approval to the Director at the NAVFAC Base Realignment Closure (BRAC) Program Management Office, Southeast.

The LUCs will be included in any lease or transfer deed. If development other than industrial use (i.e., residential or per the April 2010 amended Reuse Plan) is proposed, the new owner will be required to work with the PREQB and EPA to establish any additional investigation, risk assessment, and/or cleanup activities. If the property owner wishes to remove the LUC on the groundwater from the deed in the future, it will be the

responsibility of the property owner to demonstrate that groundwater meets all state and federal maximum contaminant levels (MCLs), and must obtain approval from the Navy, EPA, and PREQB prior to LUC removal. This CMS Addendum addresses only the soil contamination at SWMU7/8.

1.6 Justification and Rationale for Pre-excavation Delineation Activities

The CMS recommended excavation of site soils in three specific areas to remove contaminants in the upper 2 feet of soil. However, the size of the three excavation areas were calculated by Baker using a computer model, the data used in the model were collected prior to 2005, and surface soil contamination conditions may have changed with time. Therefore, it is likely that the excavation areas will differ in size and/or shape than those depicted in the CMS. AGVIQ-CH2M HILL recommended the collection of additional soil samples in the three excavation areas to verify the horizontal extent of contamination prior to mobilizing excavation equipment to the field.

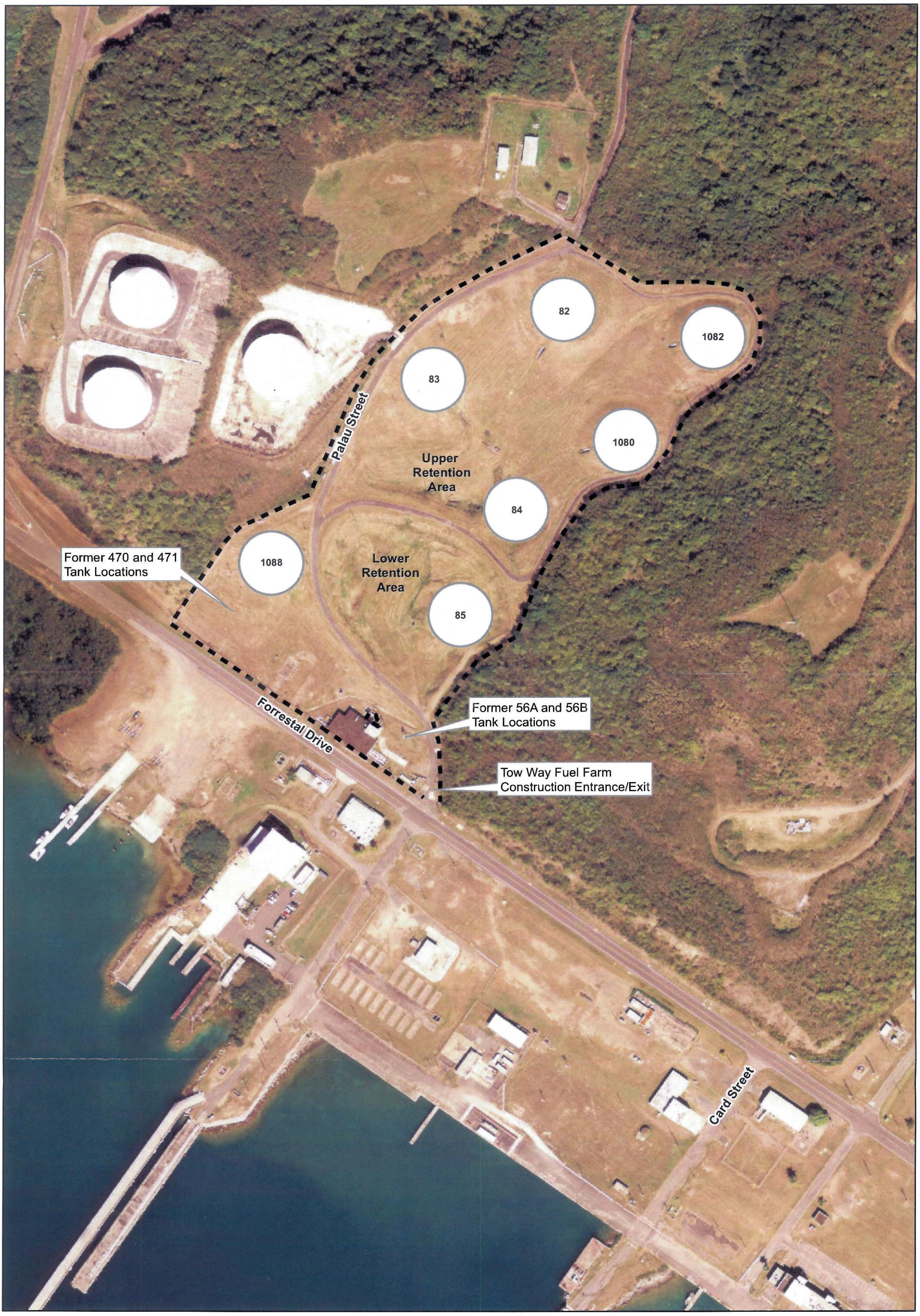


Road

Expressway

Naval Station Roosevelt Roads Boundary

FIGURE 1-1
Tow Way Fuel Farm Location
Naval Station Roosevelt Roads, Puerto Rico



Fence

Former Fuel Tank

Originated By: Thomas Kessler

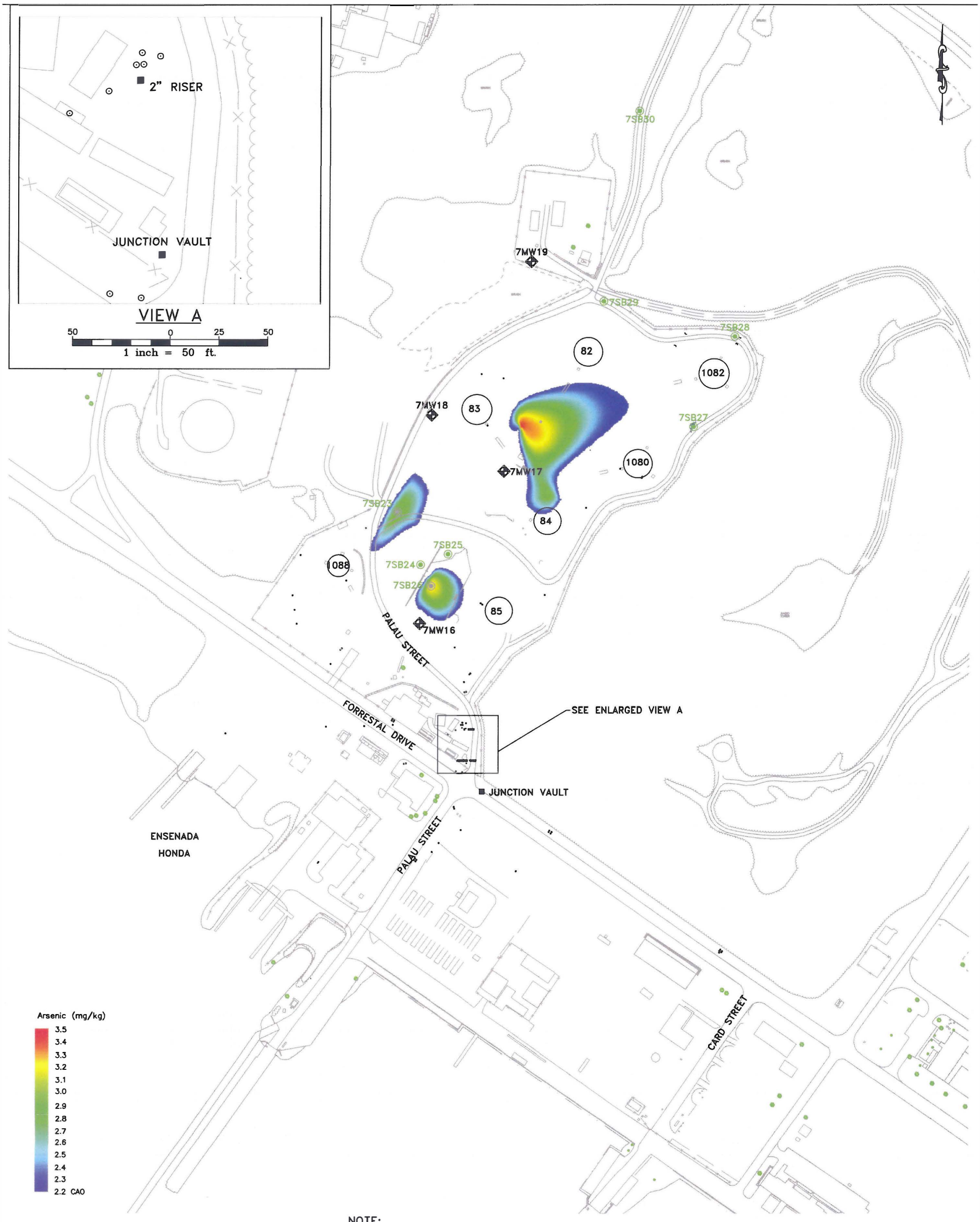
Checked By: Philip Jones

N

0 100 200 Feet

1 inch = 200 feet

FIGURE 1-2
SWMU 7/8 Base Map
Tow Way Fuel Farm
Naval Activity Puerto Rico

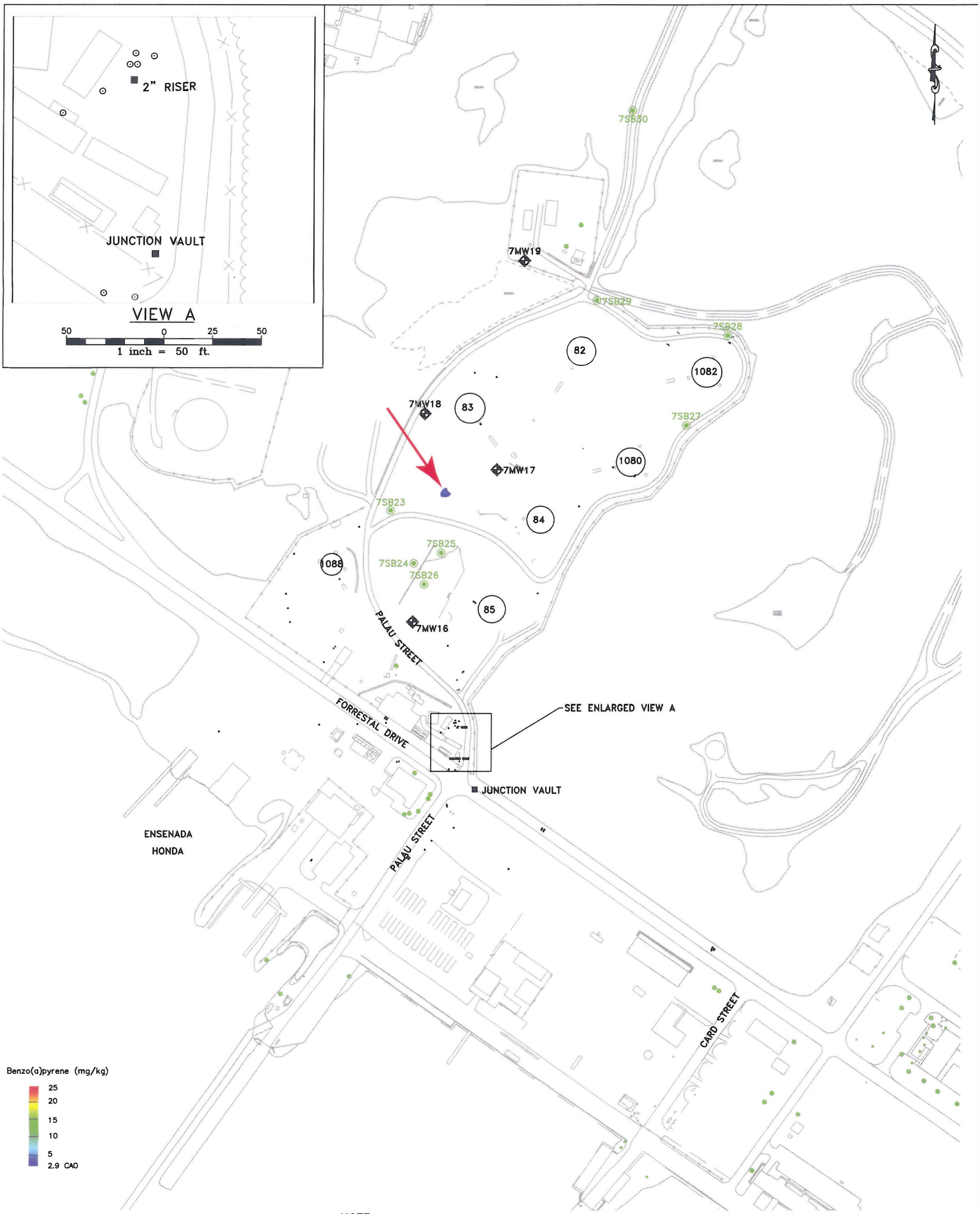


NOTE:
DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.

SOURCE: LANTDIV, FEB. 1992/1997

Source: Baker Environmental, Inc. *Revised Final CMS Final Report for TWFF*. November 22, 2005

FIGURE 1-3
Surface Soil with Arsenic Above CAO
Corrective Measures Study - Final Report
Tow Way Fuel Farm, Puerto Rico



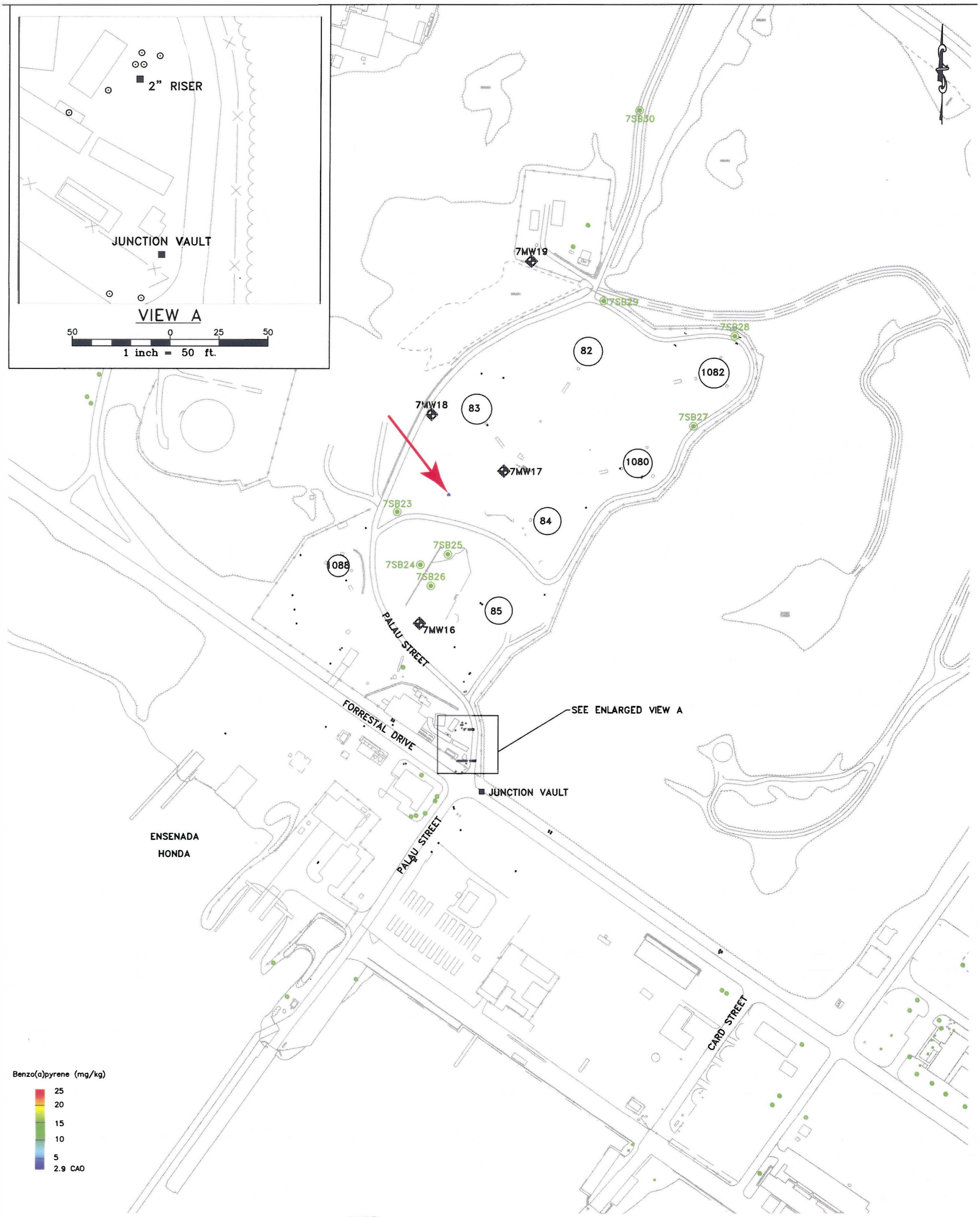
NOTE:
DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.

PRESENTED CONCENTRATION IS THE BENZO(A)PYRENE EQUIVALENT LEVEL.

SOURCE: LANTDIV, FEB. 1992/1997

Source: Baker Environmental, Inc. *Revised Final CMS Final Report for TWFF.* November 22, 2005

FIGURE 1-4
Surface Soil with Benzo(a)anthracene Above CAO
Corrective Measures Study - Final Report
Tow Way Fuel Farm, Puerto Rico



NOTE:
DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.

PRESENTED CONCENTRATION IS THE BENZO(A)PYRENE EQUIVALENT LEVEL.

SOURCE: LANTDIV, FEB. 1992/1997

Source: Baker Environmental, Inc. *Revised Final CMS Final Report for TWFF.* November 22, 2005

FIGURE 1-5
Surface Soil with Benzo(b)fluoranthene Above CAO
Corrective Measures Study - Final Report
Tow Way Fuel Farm, Puerto Rico

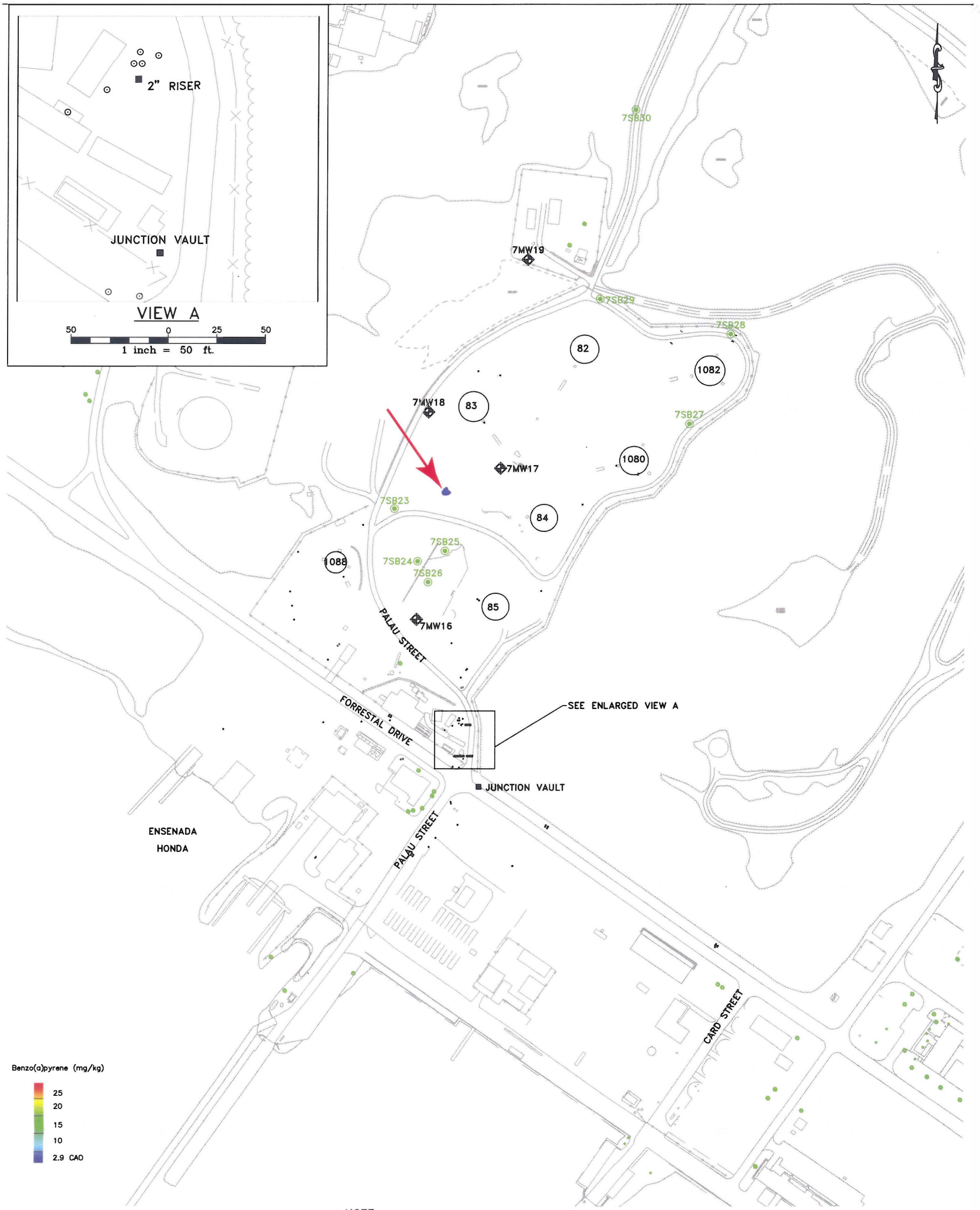
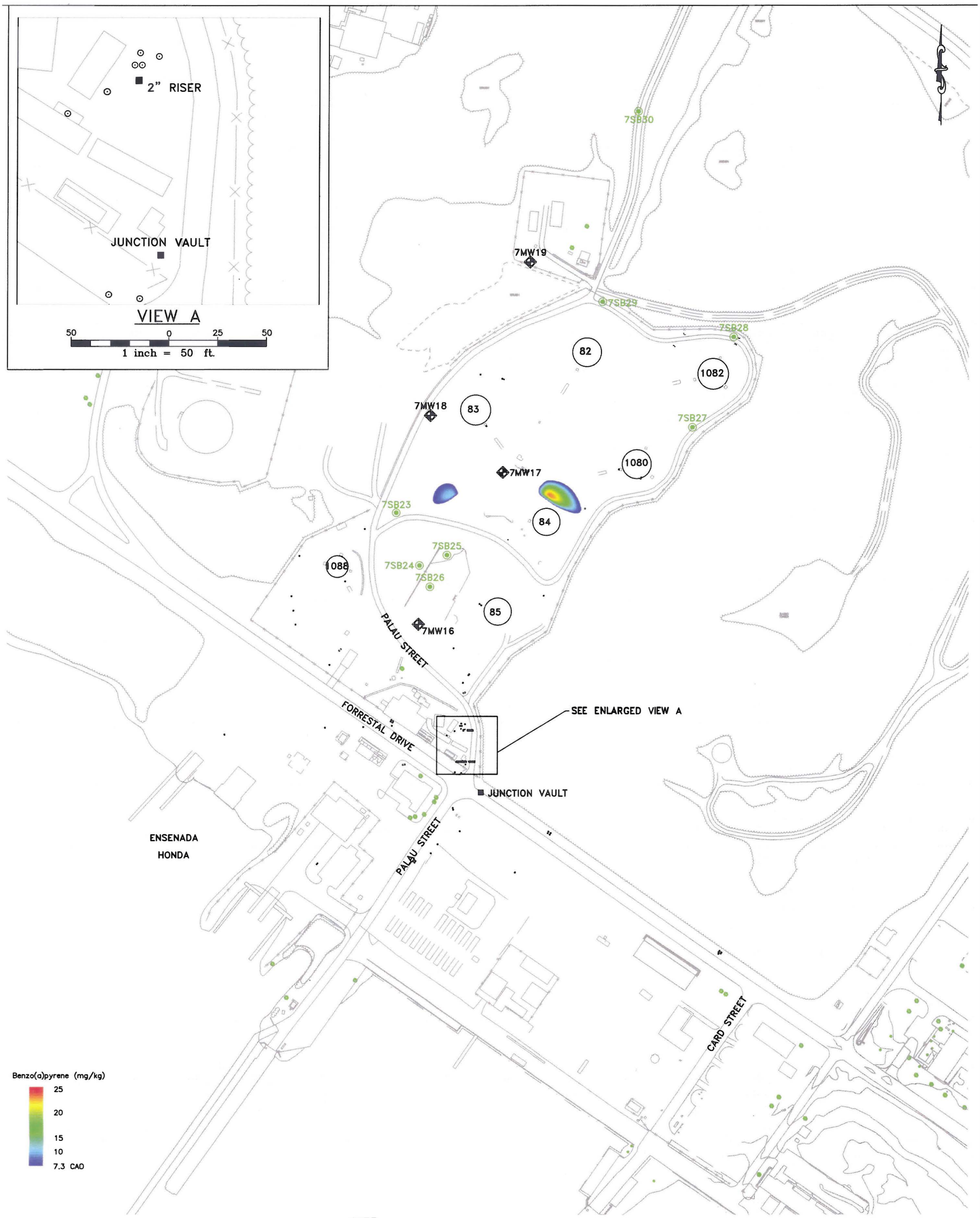


FIGURE 1-6
Surface Soil with Indeno(1,2,3-cd)pyrene Above CAO
Corrective Measures Study - Final Report
Tow Way Fuel Farm, Puerto Rico

Source: Baker Environmental, Inc. *Revised Final CMS Final Report for TWFF.* November 22, 2005



K\26007\033Phase\Draft TWFF CMS Final Rep\CMS009

NOTE:
DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.

SOURCE: LANTDIV, FEB. 1992/1997

LEGEND

- NEW MONITOR WELL LOCATION
- SOIL BORING LOCATION

FIGURE 1-7
Total (Surface and Subsurface) Soil with Benzo(a)pyrene Above CAO
Corrective Measures Study - Final Report
Tow Way Fuel Farm, Puerto Rico

Source: Baker Environmental, Inc. *Revised Final CMS Final Report for TWFF*. November 22, 2005

Existing Soil Sampling Location for SVOC

Existing Soil Sampling Location for Arsenic

Fence

Assumed Impacted Soil Area (See Note)

8TP02

Soil sample with concentrations (in milligrams per kilogram [mg/kg]) above Corrective Action Objectives (CAOs):
Arsenic: 2.65 mg/kg
Benzo(a)anthracene: 2.9 mg/kg
Benzo(a)pyrene: 2.9 mg/kg
Benzo(b)fluoranthene: 2.9 mg/kg
Indeno(1,2,3-cd)pyrene: 2.9 mg/kg
J = Estimated Detected Concentration

FIGURE 1-8

CMS Soil Delineation Sample Locations and Proposed Excavation Areas
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

CH2MHILL

2.0 Summary of Field Investigation Procedures

This section describes the work procedures that were used between January 22, 2009, and July 15, 2009 to verify the limits of excavation.

2.1 Pre-excavation Sample Grid

This CMS Addendum was issued to present the findings of the sampling completed in preparation for the soil removals originally described in the CMS. In preparation for performing the soil excavations, a soil sampling approach was designed to improve the delineation of the areas for excavation. The objectives of the post-CMS investigation defined in the Sampling and Analysis Plan (SAP) are primarily to conduct confirmatory sampling in order to do the following:

- Refine the limits of excavation because the three areas of concern as presented in the CMS were based on the extrapolation of a limited set of soil analytical data.
- Determine the current concentrations compared to those reported in the 2003 and 2005 CMS reports for the PAH compounds benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene in the upper 2 feet of soil because of the possibility that concentrations may have decreased through biological degradation and are now below the applicable CAOs.
- Determine if arsenic contamination found in SWMUs 7/8 is naturally occurring based on historical background levels. Determine if arsenic concentrations in the upper 2 feet of soil fall within the range of background concentrations for the island of Puerto Rico, and/or are present at concentrations that are statistically below the CAOs. If so, the area of arsenic contamination requiring excavation may be smaller in size or may not be required.
- Determine extent of soil contamination areas above CAOs by comparing site-wide statistical upper bound mean concentration values against the CAOs.
- Determine handling and disposal requirements by collecting soil samples for waste characterization.

Determining the above required a sampling design that optimized and adequately described the area for excavation in order to accurately define the volume of soil requiring removal and disposal, while also optimizing the total number of samples needed to be collected and analyzed. Therefore, a systematic sampling grid was placed over each of the three excavation areas identified in the original CMS. A grid spacing of 50 feet was selected to optimize the total number of samples collected from the site and yield fewer than 100 samples for the excavation delineation sampling. The grid spacing and sample location followed the systematic sampling design detailed in *Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies* (EPA, 1992). Each grid was placed at a random starting point within the site and samples were collected at the intersect nodes for the grids. As a

result, the sampling area covered the previously identified proposed excavation areas, and also extended beyond those areas covering much of the historic fuel operations area at the TWFF.

On January 22 and 23, 2009, AGVIQ-CH2M HILL personnel marked the locations of the sampling grids over the three areas of concern identified in the CMS. A grid spacing of 50 feet was used, and was developed following the EPA guidance (EPA, 1992). The grid was laid out using a Topcon® transit and engineer's tape. During the fieldwork, AGVIQ-CH2M HILL personnel attempted to install the sampling points in the locations as presented in the UFP-SAP and Work Plan (see Figure 2-1). However, the presence of obstructions (tanks and piping) and variations in topography (steep hillsides associated with USTs), necessitated moving or omitting several of the sampling locations. The actual sample locations are depicted on Figure 2-2.

2.2 Pre-Excavation Soil Sampling Procedures

The original RFI and CMS reports included surface soil samples from 0-1 foot below ground surface (bgs). The CMS recommended excavation of soils up to 2 feet bgs for implementation of corrective actions through excavation. Therefore, this CMS addendum focused on an excavation depth of up to 2 feet bgs.

Additionally, the collection of soil samples from 0-2 feet bgs was designed to support the excavation decisions. This sampling depth was considered appropriate because the original PAHs in surface soils were well above the CAO of 7.3 mg/kg and collecting surface soil samples from 0-2 feet bgs instead of the original 0-1 foot bgs affords a potential dilution factor of 2 through mixing. Samples were evaluated to determine if they indicated the presence of PAHs at comparable levels to the previously detected concentrations. A discussion of sample results is detailed in Section 3.0.

Soil sampling activities were conducted between June 1 and 4, 2009; field logbook notes are provided in Appendix C. The work was performed in accordance with the Navy approved UFP-SAP and Work Plan. Prior to beginning any intrusive work, each borehole was cleared for underground utility obstructions by One Vision, Inc. of Kennesaw, Georgia.

In areas accessible by vehicle, a truck-mounted DPT rig was used to collect continuous soil samples from the upper 2 feet of soil (0 to 2 feet bgs). A hand auger was used to collect soil samples from the upper 2 feet of soil in areas that could not be accessed by the drill rig. The DPT and hand auger work was performed by GeoEnvironTech, Inc. of Guaynabo, Puerto Rico. The DPT work was performed using a 5410 model Geoprobe® drill rig. Upon retrieval of each soil sample, the AGVIQ-CH2M HILL geologist visually inspected the sample and described the lithology encountered. Lithologic information for each sample point is summarized in Table 2-1. The soil was homogenized by placing the soil in a stainless steel bowl and mixing the soil using a stainless steel spoon. The homogenized soil was transferred to 4-ounce glass jars provided by the laboratory for chemical analysis. All samples were analyzed for arsenic using EPA Method 6010B, and select samples were analyzed for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene using EPA Method 8270C. The analyses performed at each sample location are shown on Figure 2-2 and test results are included in Table 2-1. As illustrated on Figure 2-2,

samples from locations A24 and B7 were not analyzed for PAHs because of the observed presence of asphalt in the soil, which is a common source of PAH compounds. Therefore, the samples from locations A24 and B7 were only analyzed for arsenic.

The samples were labeled using the alphanumeric coordinate system depicted on Figure 2-2. Sample nomenclature consisted of the task order number, the alphanumeric coordinate, sample depth, and sampling date. For example, a sample was collected at location B10 on June 4, 2009; therefore, the sample identification (ID) is JM04-B10(2.0)-060409.

The soil samples were logged, stored in 4-ounce glass jars, wrapped in bubble wrap, double-sealed in Ziploc® bags, and packed on ice for shipment to Empirical Laboratories, Inc., located in Nashville, Tennessee, following standard chain-of-custody procedures. Laboratory data sheets and chain-of-custody records are provided in Appendix A.

A total of 72 soil samples were collected during the pre-excavation delineation sampling event. For quality assurance/quality control (QA/QC) purposes, 15 additional samples were submitted for QA/QC analysis. These samples included three matrix spike/matrix spike duplicates, seven duplicate samples, and five equipment blanks. Results of the sample analysis are discussed in Section 3 and presented in Appendix A.

2.3 Borehole Abandonment

Upon completion of the work, the DPT and hand auger boreholes were filled with a Portland cement/grout slurry containing 3 to 5 percent bentonite.

2.4 Surveying

Following the completion of sampling activities, each sample location was surveyed (horizontal location and vertical elevation) by Pedro J. Davila Colon of PJDC, Inc., a Puerto Rico-licensed land surveyor. The surveying work was performed between July 2, 2009, and July 15, 2009. Locations were surveyed relative to previously established benchmarks. Coordinate data for each sampling location are presented on Table 2-1.

Table 2-1
Pre-Excavation Soil Delineation Sample Summary at SWMU 7/8 (June 2009)
Roosevelt Roads Naval Station, Puerto Rico

Sample Date	Station ID	Coordinates		Elevation	Sample ID	Sample method	Quality Control	USCS	Description	Proximity to existing Asphalt	Other notes
		Easting	Northing	feet NGVD 29							
6/3/2009	A1	782265.280	147022.775	74.00	JM04-A1(2.0)-060309	Hand Auger	---	CL	Silty Clay with cobbles, cobbles are angular gabbro, firm, moderate moist at top to low moisture near bottom, brown, (10YR 4/3)	>30'	Sample collected with hand auger due to accessibility issues.
6/3/2009	A2	782312.690	147036.239	69.70	JM04-A2(2.0)-060309	Hand Auger	---	OL	Silty Clay, Organic, low to medium plasticity, very stiff, moderate moist, brown (5YR 4/2)	>30'	---
--	A3	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of piping and UST - no sample collected
--	A4	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of UST - no sample collected
--	A5	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of UST - no sample collected
6/3/2009	A6	782222.222	146961.035	71.71	JM04-A6(2.0)-060309	Hand Auger	---	CL	Silty Clay, angular cobbles, firm, Brown (10YR 4/4)	>30'	Sample collected with hand auger due to accessibility issues.
6/3/2009	A7	782268.962	146973.733	66.05	JM04-A7(2.0)-060309	Hand Auger	---	CL	Silty Clay, ~20% angular cobbles, 30% silt, 50% clays, moderate moisture, low to moderate plasticity, dark brown (10YR 3/3)	>30'	Sample collected with hand auger due to accessibility issues.
6/3/2009	A8	782316.551	146986.591	62.67	JM04-A8(2.0)-060309	Hand Auger	Field Duplicate	OH	Silty Clay, high plasticity, moderate moisture, ~80% Clay, trace angular cobbles, very stiff, brown (10YR 4/2)	>30'	Sample collected with hand auger due to accessibility issues.
6/4/2009	A9	782365.126	146999.485	63.70	JM04-A9(2.0)-060409	DPT	---	CL/ GW	Silty Clay with cobbles, ~50% angular gravel and cobble, soil is silty clay ~40 silt, moderate moisture, low to moderate plasticity, moderate cohesion, light to dark brown (10YR 5/4)	>30'	---
6/4/2009	A10	782411.978	147010.776	69.86	JM04-A10(2.0)-060409	Hand Auger	MS/MSD	OL	Silty Clay, moderate plasticity, high moisture, angular cobbles, no odor, trace **asphalt** debris brown (10YR 4/2)	>30'	Sample contained asphalt debris but was not originally scoped to be sampled for PAH's.
6/3/2009	A11	782461.168	147011.818	69.70	JM04-A11(2.0)-060309	Hand Auger	---	CL	Silty Clay, ~50% clay, little sands, angular cobbles, wet at top, dry near bottom, thin SW layer near bottom, dark brown (10YR 4/2)	>30'	Sample collected with hand auger due to accessibility issues.
6/3/2009	A12	782496.254	147020.861	68.25	JM04-A12a(2.0)-060309	Hand Auger	---	CH	Clay, little silt, little angular cobble, "modeling clay" gleyed color with red mottling, moderate moisture, high plasticity, strong cohesion, stiff, gray-brown (10Y 6/3)	>30'	Sample collected with hand auger due to accessibility issues. Sample was moved 10 feet southeast due to accessibility issues.
--	A13	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of UST - no sample collected
6/3/2009	A14	782224.442	146911.443	59.05	JM04-A14(2.0)-060309	Hand Auger	MS/MSD	CL	Silty Clay with cobbles, ~30% silt, 50% clay, moderate to low moisture, low plasticity, dark brown (10YR 4/3)	>30'	Sample collected with hand auger due to accessibility issues.
6/2/2009	A15	782270.728	146924.789	55.66	JM04-A15(2.0)-060209	DPT	---	CL/ GW	Silty Clay with cobbles, ~70% clay, cobbles are angular, low moisture, low plasticity, very stiff, brown (10YR 4/4)	>30'	---
6/2/2009	A16	782318.965	146937.109	56.86	JM04-A16(2.0)-060209	DPT	Field Duplicate	SW ML	Silty Sand/ Sandy Silt, Sand is fine to very coarse grained, ~40% cobbles, angular, dry, Brown (5Y 5/2)	>30'	---

Table 2-1
Pre-Excavation Soil Delineation Sample Summary at SWMU 7/8 (June 2009)
Roosevelt Roads Naval Station, Puerto Rico

Sample Date	Station ID	Coordinates		Elevation	Sample ID	Sample method	Quality Control	USCS	Description	Proximity to existing Asphalt	Other notes
		Easting	Northing	feet NGVD 29							
6/4/2009	A17	782366.883	146949.807	60.17	JM04-A17(2.0)-060409	DPT	---	OH	Silty Clay with sand and cobbles, low cohesion, high plasticity, organic, fine sands ~15%, trace angular cobbles, ~45% clay, ~40% silts, moderate moisture dark brown (10YR 3/2)	>30'	---
6/4/2009	A18	782415.376	146961.725	65.05	JM04-A18(2.0)-060409	DPT	---	CH	Clay, few angular cobbles, high plasticity, moderate moisture, ~40% silts, moderate cohesion, brown (10YR 4/3)	>30'	---
6/4/2009	A19	782464.473	146974.042	68.67	JM04-A19(2.0)-060409	DPT	---	CL	Silty Clay, ~35% silt, good cohesion, low plasticity, moderate to low moisture, gray and brown (5YR 6/2)	>30'	---
6/3/2009	A20	782512.975	146986.978	70.75	JM04-A20(2.0)-060309	DPT	---	CL	Silty Clay, low to moderate plasticity, one 2" thick zone of CH near 2' bgs, medium sti , moderate moist, ~35% silt, some organic material, brown (10YR 3/4)	>30'	---
--	A21	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of piping and UST - no sample collected
6/2/2009	A22	782226.363	146862.636	50.81	JM04-A22(2.0)-060209	DPT	Field Duplicate	ML	Clayey Sandy Silt, low moisture, low plasticity, trace angular gravel, little organic clay, brown (5Y 3/4)	>30'	---
6/2/2009	A23	782275.211	146874.895	51.82	JM04-A23(2.0)-060209	DPT	---	CL	Silty Clay with gravel and cobbles, dry, has no odor, contains some "black specks" (10Y 3/2)	>30'	This sample was closely examined to verify there was no asphalt in the sample, the "black specks" were tiny chips of gabbro.
6/2/2009	A24	782323.614	146887.774	54.23	JM04-A24(2.0)-060209	DPT	---	CL	Silty Clay with cobbles, very stiff, low moisture, trace odor, contains **asphalt** fragments, brown (5Y 4/2)	>30'	No PAH sample taken due to the presence of asphalt in the sample collected.
6/4/2009	A25	782371.032	146899.353	58.73	JM04-A25(2.0)-060409	DPT	Field Duplicate	OL	Silty Clay, little angular very coarse sand, gravel, and cobble, low plasticity, good cohesion, moderate moisture, abundant organics, brown (10YR 4/3)	>30'	---
6/3/2009	A26	782419.115	146911.606	63.56	JM04-A26(2.0)-060309	DPT	---	CH	Silty Clay, high to moderate plasticity, moderate moisture, medium stiff, dark brown (10YR 3/4)	>30'	---
6/3/2009	A27	782468.611	146924.622	67.13	JM04-A27(2.0)-060309	DPT	---	CH	Clay, high plasticity, little silt, moderate moisture, trace very course sands, light brown (10YR 3/4)	>30'	---
6/2/2009	A28	782229.996	146812.279	46.58	JM04-A28(2.0)-060209	DPT	---	ML	Sandy Silt with cobbles, low moisture, angular cobbles, little sand, some clays, dark brown (5Y 4/3)	>30'	---
6/2/2009	A29	782278.144	146824.565	50.02	JM04-A29(2.0)-060209	DPT	---	ML	Gravelly Clayey Silt, dry, low plasticity, very sti f, little organic clay, brown (5Y 4/4)	>30'	---
6/2/2009	A30	782325.983	146837.821	52.94	JM04-A30(2.0)-060209	DPT	---	CL	Silty Clay, Stiff, with gravel, low moisture, angular cobble and gravel, little sand, light brown (10YR 4/3)	>30'	---
6/2/2009	A31	782374.454	146850.432	56.67	JM04-A31(2.0)-060209	DPT	---	ML	Clayey Silt, low plasticity, ~30% clays, some angular cobbles, little fine to course sands, moderate moisture, brown (5Y 7/3)	>30'	---
6/2/2009	A32	782422.594	146861.752	60.78	JM04-A32(2.0)-060209	DPT	---	CL	Clay, little silt, no sands, very stiff, low plasticity, low moisture, trace gray lamination, reddish brown (5YR 4/6)	>30'	---

Table 2-1
Pre-Excavation Soil Delineation Sample Summary at SWMU 7/8 (June 2009)
Roosevelt Roads Naval Station, Puerto Rico

Sample Date	Station ID	Coordinates		Elevation	Sample ID	Sample method	Quality Control	USCS	Description	Proximity to existing Asphalt	Other notes
		Easting	Northing	feet NGVD 29							
6/2/2009	A33	782233.911	146763.622	44.48	JM04-A33(2.0)-060209	DPT	---	ML	Sandy Silt, Stiff, little sand, some clays, low plasticity, low moisture, few angular cobbles, dark brown (5Y 4/3)	>30'	---
6/2/2009	A34	782282.361	146775.153	48.38	JM04-A34(2.0)-060209	DPT	---	ML	Sandy Silt with lean clay lense and cobbles, low to moderate moisture, clay has moderate plasticity cobbles are angular, sand is ~20%, dark brown (5Y 3/2)	>30'	---
6/2/2009	A35	782330.677	146786.999	52.54	JM04-A35a(2.0)-060209	DPT	---	CL	Silty Clay with cobbles, very stiff, cobbles are angular ~ 50% cobbles, low moisture, soil is dark brown (5Y 4/2)	>30'	Sample location moved 5 feet to the north to allow for utilities, first attempt yielded no return.
6/2/2009	A36	782376.892	146800.395	60.10	JM04-A36(2.0)-060209	DPT	---	OL	Silty Clay, Stiff, ~35% silt, little sand, trace angular cobbles, low moisture, dark brown (5Y 4/2)	>30'	---
6/2/2009	A37	782232.443	146714.574	42.86	JM04-A37(2.0)-060209	DPT	---	ML/ GW	Silt with cobbles and gravel, angular, low moisture, some organic clays, dark brown (5Y3/2)	>30'	---
--	A38	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of UST - no sample collected
6/2/2009	A39	782333.512	146738.135	57.43	JM04-A39(2.0)-060209	DPT	---	ML/ GW	Cobbly Silt, ~70% cobbles, sandy silt matrix, little organic clay, dry, dark brown (5Y 4/2)	>30'	Sample moved 5 inches west due to no recovery on first attempt
6/2/2009	A40	782380.125	146750.176	65.20	JM04-A40(2.0)-060209	Hand Auger	---	ML/ GW	Sandy Silt with cobbles, some clays, low moisture, angular cobbles, dark brown 10YR 3/3	>30'	Sample collected with hand auger due to accessibility issues.
6/2/2009	A41	782382.410	146700.951	71.30	JM04-A41(2.0)-060209	Hand Auger	MS/MSD	CL/ GW	Silty Clay with cobbles, Moderate moisture, low to moderate plasticity, angular cobbles, brown (10YR 4/3)	>30'	Sample collected with hand auger due to accessibility issues.
--	A42	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of piping and UST - no sample collected
--	A43	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of UST - no sample collected
--	A44	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of UST - no sample collected
--	A45	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of UST - no sample collected
6/4/2009	B1	781998.036	146811.458	55.02	JM04-B1(2.0)-060409	DPT	---	ML	Sandy Silt, little clay, sand is fine to coarse grained, low moisture to dry, few angular cobbles, loose, light brown (5Y 6/3)	>30'	---
6/4/2009	B2	782042.100	146795.968	50.36	JM04-B2(2.0)-060409	DPT	---	ML	Clayey Silt with cobbles, moderate moisture, low plasticity, low cohesion, little fine sands, ~35% angular gravel and cobble, Brown 10YR 5/4	>30'	---
6/4/2009	B3	782086.507	146779.982	43.70	JM04-B3(2.0)-060409	Hand Auger	Field Duplicate	CL	Silty Clay with sand, low cohesion, moderate moisture, low plasticity, sand is fine to very coarse grained, angular, abundant gravel, dark brown (10YR 3/2)	>30'	Sample collected with hand auger due to accessibility issues.

Table 2-1
Pre-Excavation Soil Delineation Sample Summary at SWMU 7/8 (June 2009)
Roosevelt Roads Naval Station, Puerto Rico

Sample Date	Station ID	Coordinates		Elevation	Sample ID	Sample method	Quality Control	USCS	Description	Proximity to existing Asphalt	Other notes
		Easting	Northing	feet NGVD 29							
6/4/2009	B4	781930.684	146775.891	55.54	JM04-B4(2.0)-060409	DPT	---	SM	Silty Sand with little clay, silt and clay are in zones with coarse angular sands, sand throughout is fine to very coarse grained, trace angular cobbles, dry, loose, light brown (5Y 7/6)	>30'	---
6/4/2009	B5	781977.782	146761.991	52.03	JM04-B5(2.0)-060409	DPT	---	ML	Sandy Silt, little clay, sand is fine grained to cobble, angular, ~40% sand, 50% silt, 10% clay, low plasticity, dry, brown (5Y 4/4)	>30'	---
6/4/2009	B6	782025.433	146749.192	46.70	JM04-B6(2.0)-060409	DPT	Field Duplicate	OH/ SW	Silty Clay top 4", organic, little sand, trace cobble, Sand bottom 20", fine to very coarse grained with trace angular cobble and trace fines, dry, brown (5Y 6/3)	>30'	---
6/4/2009	B7	782072.620	146738.431	41.37	JM04-B7(2.0)-060409	Hand Auger	---	CL	Silty Clay with sand and cobbles, sand is fine to very coarse, cobbles are angular, moderate moisture, 3 small specs of **asphalt/tar** located within the sample. dark brown (5Y 7/3)	>30'	Sample was not collected for PAH's due to the presence of Asphalt debris
6/4/2009	B8	781913.149	146729.521	53.02	JM04-B8(2.0)-060409	DPT	---	SM/ GW	Silty Sand with cobbles, sample is ~75% cobbles, angular, trace clays as matrix in very coarse sand (like a saprolite), dry, loose, light brown (5Y 7/4)	12' east	---
6/4/2009	B9	781960.779	146718.079	53.75	JM04-B9(2.0)-060409	DPT	---	ML/ SM	Sandy Silt - Silty Sand, trace clays, abundant angular gravel and cobble, dry, loose, light brown (5Y 7/3)	21' north	---
6/4/2009	B10	782009.902	146707.200	54.51	JM04-B10(2.0)-060409	DPT	MS/MSD	ML/ SM	Sandy Silt - Silty Sand, with cobbles, angular, ~50% cobbles, low moisture, loose, light brown (5Y 7/3)	12' north	---
6/4/2009	B11	782058.597	146695.129	55.62	JM04-B11(2.0)-060409	DPT	---	ML	Sandy Silt with Cobbles	13' north	---
6/4/2009	B12	782106.736	146684.457	56.14	JM04-B12(2.0)-060409	DPT	Field Duplicate	ML	Sandy Silt with cobbles, trace clay, ~40% cobbles, angular, sand is fine to medium grained, little course to very coarse grained, moderate moisture, soft, low plasticity, low cohesiveness, dark brown (10YR 4/3)	13' north	---
6/4/2009	B13	781851.323	146686.101	50.79	JM04-B13(2.0)-060409	DPT	---	GW/ SM	Angular Cobbles with silty sand and fill sand, mostly fine grained, some medium to coarse grained and gravel, low moisture, loose, light brown (5Y 7/4)	20' west	---
6/4/2009	B14	781900.206	146679.898	51.02	JM04-B14(2.0)-060409	DPT	---	SM/GW	Silty Sand with cobbles, top 2" are organic clay, sand is fine grained to very coarse, angular with abundant gravel and cobble, dry, loose, light brown (5Y7/3)	12' north, 18' east	---
6/4/2009	B15	781946.544	146672.126	51.37	JM04-B15(2.0)-060409	DPT	---	ML	Sandy Silt with cobbles, little clay, ~65% silts, cobbles are angular, low moisture, low plasticity, low cohesiveness, dark brown (10YR 4/3)	>30'	---
--	B16	---	---	---	NA	---	---	---	---	---	No sample collected due to steep topography and unsafe conditions
--	B17	---	---	---	NA	---	---	---	---	---	No sample collected due to steep topography and unsafe conditions
6/4/2009	B18	781837.431	146638.485	49.69	JM04-B18(2.0)-060409	DPT	---	SM	Silty Sand with cobbles and gravel, sand is fine to very coarse grained, dry, loose, light brown (5YR 7/3)	30' west	---
6/4/2009	B19	781886.787	146631.536	47.89	JM04-B19(2.0)-060409	DPT	---	SM	Silty Sand with cobbles, fine to very coarse grained, cobbles are angular, dry, loose, light brown (5Y 7/3)	7' east, 33' south	---

Table 2-1
Pre-Excavation Soil Delineation Sample Summary at SWMU 7/8 (June 2009)
Roosevelt Roads Naval Station, Puerto Rico

Sample Date	Station ID	Coordinates		Elevation	Sample ID	Sample method	Quality Control	USCS	Description	Proximity to existing Asphalt	Other notes
		Easting	Northing	feet NGVD 29							
--	B20	---	---	---	NA	---	---	---	---	---	No sample collected due to steep topography and unsafe conditions
--	B21	---	---	---	NA	---	---	---	---	---	No sample collected due to steep topography and unsafe conditions
6/4/2009	B22	781851.968	146579.025	44.97	JM04-B22(2.0)-060409	DPT	---	SM	Silty Sand with gravel and cobbles, 4" thick zone of SP fill sand near top, gravel is angular, fine to coarse grained, low moisture, loose, light brown (5Y 7/3)	9' west	---
6/4/2009	B23	781880.131	146582.390	44.35	JM04-B23(2.0)-060409	DPT	---	SM	Silty Sand with gravel and cobbles, 4" thick zone of SP fill sand near top, gravel is angular, fine to coarse grained, low moisture, loose, light brown (5Y 7/3)	9' east	---
6/4/2009	B24	782014.460	146858.756	60.37	JM04-B24(2.0)-060409	DPT	---	OH/ SW	Silty Clay, top 12", organic, trace cobble and coarse sands, angular, Sand, bottom 12", Fine to very coarse grained with some gravel and cobble, dry, loose, light brown (5Y6/3)	>30'	---
6/4/2009	B25	782060.177	146841.826	52.82	JM04-B25(2.0)-060409	DPT	---	CL/ SW	Silty Clay, top 8", moderate moist, trace angular cobble, low to medium plasticity, dark brown (10YR 4/3) Sand, bottom 16", well graded, find to cobble, angular, few fines (<25%), dry, light brown (5Y 6/3)	>30'	---
6/4/2009	B26	782106.018	146825.561	50.28	JM04-B26(2.0)-060409	DPT	---	OH/ SP	Clay, Top 1,' organic high plasticity, moderate moisture , Sand bottom 1' fine grained with little cobble, possibly dirty fill sand, dry, dark brown to light gray (5Y3/2) & (5Y 7/1)	>30'	---
6/4/2009	B27	781952.770	146827.819	58.62	JM04-B27(2.0)-060409	DPT	---	SM	Silty Sand with little clay, clay is near bottom of sample as matrix in gravelly cobbly layer, sand is fine to very coarse grained, angular, ~30% silt, ~10% clay, dry, light brown (5Y 7/3)	>30'	---
6/1/2009	C1	781950.281	146563.206	19.37	JM04-C1(2.0)-060109	DPT	---	SM/ ML	Angular cobbles, topsoil, silt, ~50% sand, dry, light brown	>30'	---
6/1/2009	C2	781998.953	146572.770	20.63	JM04-C2(2.0)-060109	DPT	---	SW/ CL	Angular cobbles, sand, fine to cobble, dry, silty clay last 2 inches, light brown	>30'	---
6/1/2009	C3	782048.769	146582.975	22.96	JM04-C3(2.0)-060109	DPT	---	SW	Silty Sand, trace fines, angular, dry, light brown	>30'	---
--	C4	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of piping and UST - no sample collected
6/1/2009	C5	781961.084	146514.491	17.91	JM04-C5(2.0)-060109	DPT	---	CL	2" gravel then Silty-Clay, trace gravel, low moisture, dark brown	>30'	---
6/1/2009	C6	782009.998	146524.016	20.28	JM04-C6(2.0)-060109	DPT	---	SW	Sand, fine to cobble, angular, trace silts and clays, dry, loose, light brown	>30'	---
6/1/2009	C7	782053.193	146533.603	22.56	JM04-C7a(2.0)-060109	DPT	---	SW	Silty Sand, fine to cobble, angular, dry, light brown	>30'	Sample location moved 5 feet north to allow for utilities.
6/1/2009	C8	782100.448	146544.007	24.06	JM04-C8a(2.0)-060109	DPT	---	OL	Silty Clay, stiff, trace cobbles, moderate moisture, organic, dark brown	>30'	Sample location moved 5 feet west to allow for utilities.

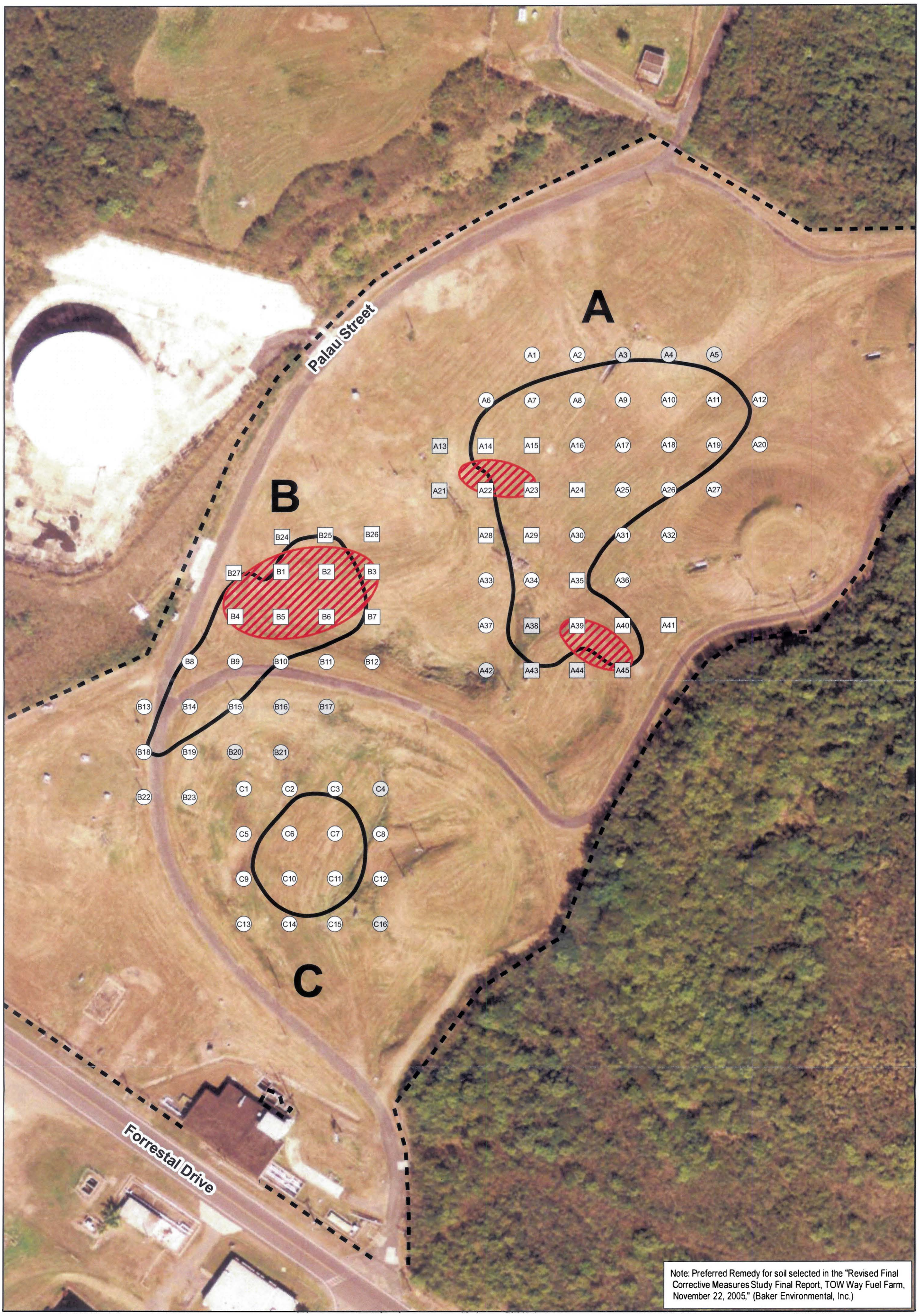
Table 2-1
Pre-Excavation Soil Delineation Sample Summary at SWMU 7/8 (June 2009)
Roosevelt Roads Naval Station, Puerto Rico

Sample Date	Station ID	Coordinates		Elevation	Sample ID	Sample method	Quality Control	USCS	Description	Proximity to existing Asphalt	Other notes
		Easting	Northing	feet NGVD 29							
6/1/2009	C9	781971.316	146465.569	18.17	JM04-C9(2.0)-060109	DPT	---	OL/SP	0-1' = Clay with some silt, stiff, moderate moist, organic, dark brown 1-2' = Fill Sand mixed with gravel, loose, dry, light brown	>30'	---
6/1/2009	C10	782020.260	146475.443	19.50	JM04-C10(2.0)-060109	DPT	---	SP	Fill Sand, trace fines near top, some gravel, light yellow-brown	>30'	---
6/1/2009	C11	782068.854	146484.252	21.39	JM04-C11(2.0)-060109	DPT	---	ML/ SP	Sandy Silt, then fill sand, sand is fine grained and subround, light brown	>30'	---
6/1/2009	C12	782117.203	146493.683	28.24	JM04-C12(2.0)-060109	Hand Auger	---	SM	Silty Sand with cobbles, moderate moist to dry, light to dark brown	>30'	Sample collected with hand auger due to accessibility issues.
6/1/2009	C13	781978.282	146425.766	17.88	JM04-C13a(2.0)-060109	DPT	---	SW	Sand, cobbly, angular, trace fines, trace organics, dry, light brown	>30'	Moved 5 feet to the north to allow for utilities
6/1/2009	C14	782029.473	146426.044	16.67	JM04-C14(2.0)-060109	DPT	---	SM	Silty Sand, some clays, some cohesiveness, fine to very course sand, trace cobbles, loose, dry, light brown	>30'	---
6/1/2009	C15	782066.731	146433.122	15.46	JM04-C15(2.0)-060109	Hand Auger	Field Duplicate	SM	Silty Sand, cobbles and organics, sand is fine grained to cobble, angular, low moisture, loose, light brown,	>30'	Sample collected with hand auger due to accessibility issues.
--	C16	---	---	---	NA	---	---	---	---	---	Cannot excavate soil due to presence of piping and UST - no sample collected

Notes:
--- = no data collected
DPT = direct push technology
NA = not accessible
PAH = Poly Aromatic Hydrocarbon
USCS = United Soil Classification System

USCS Details

First and/or Second Letter	Second Letter
G = Gravel	P = Poorly Graded
S = Sand	W = Well Graded
M = Silt	H = High Plasticity
C = Clay	L = Low Plasticity
O = Organic	



Soil Delineation Sampling Point (50 Foot Intervals)

Arsenic

Arsenic and PAHs

PAHs = Benzo(a)anthracene
Benzo(a)Pyrene
Benzo(a) fluoranthene
Benzo(1,2,3-cd)Pyrene

Grayed sample locations indicate areas where samples cannot be collected due to topography or existing structures

Assumed Arsenic Impacted Soil Area (See Note)

Fence

PAH Excavation Area

N

0 50 100 Feet

1 inch = 100 feet

FIGURE 2-1

Proposed Soil Delineation Sample Locations
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

CH2MHILL

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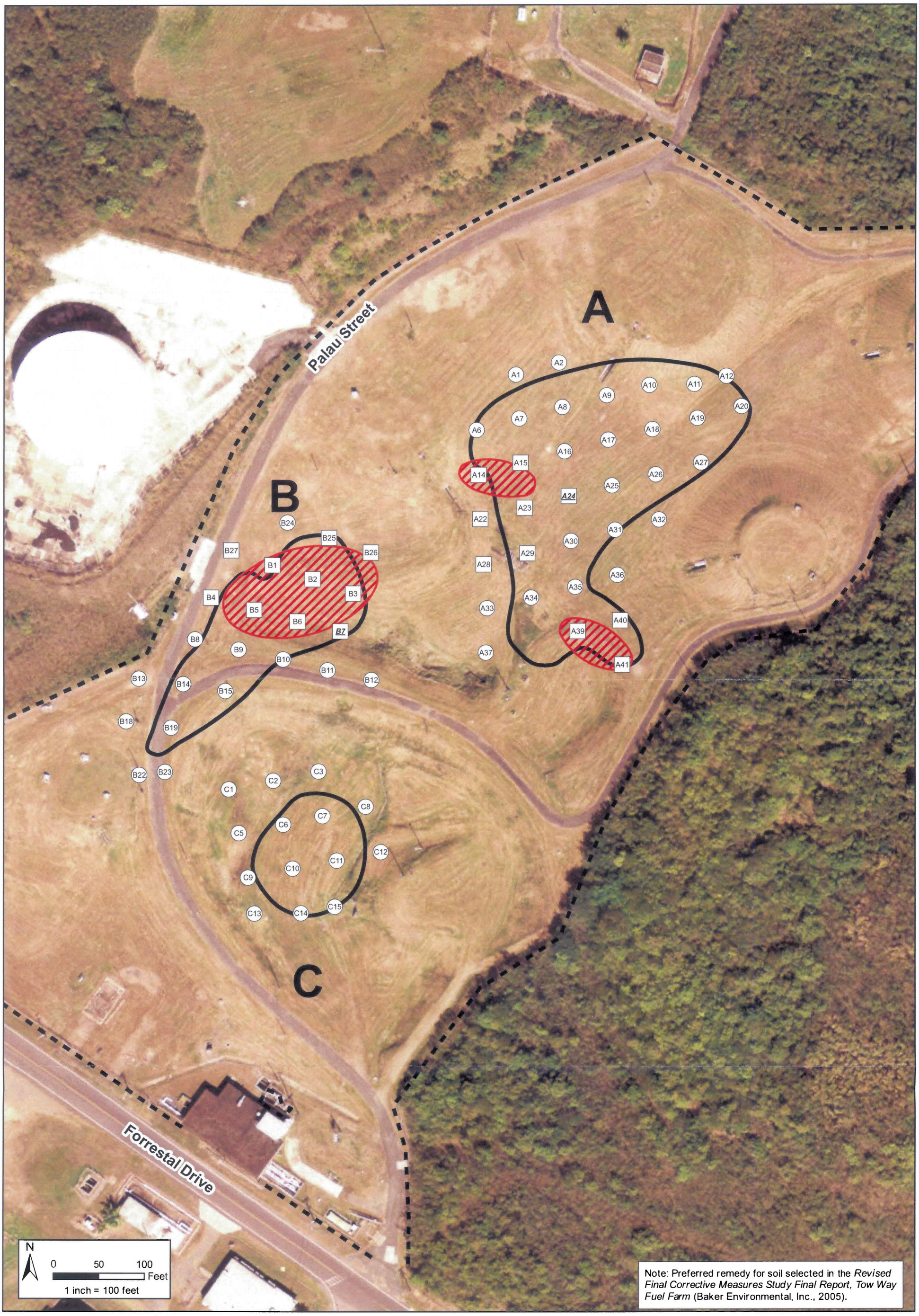

Soil Delineation Sampling Point

- Arsenic
- Arsenic and Polynuclear Aromatic Hydrocarbons (PAHs)
- Fence
- Assumed Arsenic Impacted Soil Area (See Note)
- PAH Excavation Area (See Note)

PAHs = Benzo(a)anthracene
Benzo(a)Pyrene
Benzo(a) fluoranthene
Benzo(1,2,3-cd)Pyrene

A24 = Asphalt present in soil sample. Sample only tested for arsenic.

FIGURE 2-2
Soil Delineation Sample Locations
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

CH2MHILL

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3.0 Discussion of Results

Analytical results are summarized in Table 3-1, and the laboratory reports are presented in Appendix A. Data for the analyses were reviewed for adherence to the analytical protocols presented in the approved UFP-SAP and Work Plan. All analytical results were evaluated by a Puerto Rican chemist, validated and qualified by an AGVIQ-CH2M HILL certified chemist, and a third-party validator in accordance with the guidance provided in the *Department of Defense Quality Systems Manual - Version 3 Final* (based on National Environmental Laboratory Accreditation Conference Voted Version 5 – June 2003) presented in the UFP-SAP.

3.1 PAHs

The revised Final CMS report (Baker, 2005) included PAHs as final COCs in surface soils in three areas, based on exceedance of the CAOs. The CAOs identified for surface soil were protective of an industrial worker and the CAOs for total soil that includes both surface and subsurface soil were based on protection of construction workers. This CMS addendum also screened the site soil PAH analytical against the revised CAOs from June 20112, and also against residential land use based Regional Screening Levels (RSLs) as included in Table 1-2 in order to evaluate the need for corrective actions under industrial land use as well as to consider the soil contamination conditions under future unrestricted land use scenario, to be conservatively protective of potential human exposures.

The revised RFI report (Baker, 1997) included the PAH concentrations from soil samples as benzo(a)pyrene equivalent (BEQ) levels. The reported BEQ levels in soils from the historical samples reported in the RFI report ranged between 0.0013 mg/kg to 23 mg/kg, compared to an industrial RBC of 0.78 mg/kg and residential RBC of 0.088 mg/kg from the RFI. The industrial RBC was identified as the CAO in the original CMS report for the remedial alternatives screening. Later during the comment review period, EPA recommended use of 2.9 mg/kg as the industrial worker protective level, which became the identified CAO for the 2005 CMS report. The areas identified for corrective actions based on detection of individual PAHs converted to BEQ levels were presented in the final CMS report (Baker, 2005), and these figures are presented in Section 1.0 (Figures 1-4 to 1-7).

To further delineate the current levels of PAHs in the proposed excavation areas identified during the previous Final CMS from 2005, additional samples were collected in 2009 and summarized in this CMS Addendum report (Figure 3-1). The analytical results for PAHs identified as COCs in the RFI and 2005 CMS reports were included in this CMS Addendum report, analyzed by EPA's SW-846 method 8270C (see Appendix A).

During the review of draft version of this CMS Addendum report, EPA recommended CAOs previously proposed in the 2005 CMS be revised, as described in Section 1.4. and included in Table 1-2, current revised CAOs for industrial land use at 7.3 mg/kg for benzo(a)pyrene is slightly higher than the 2.9 mg/kg from 2005 CMS report. The revised CAOs (i.e., RSLs) for residential land use (Table 1-2) are slightly lower than the RBC values

previously identified (Table 1-1). The results of the comparison of revised CAOs to the 2009 sample results are included in Table 3-1.

The analytical results indicated that all normal sample results were below the reporting limits as well as below the method detection limits (MDLs). However, the detection limits (DLs), which included both MDLs and reporting limits (RLs). The MDLs (0.13-0.42 mg/kg) are approximately an order of magnitude lower than the RLs (1.8 – 2.4 mg/kg), as included in Appendix A. Thus, the DLs ranged between 0.13 mg/kg to 2.4 mg/kg, which are higher than the residential CAOs, but lower than the industrial CAOs. Based on the undetectable level PAHs, it is likely the PAHs are no longer occurring in surface soil due to natural degradation/attenuation. However, because DLs are higher than the residential RSLs for unrestricted land use, a low level of uncertainty exists for future unrestricted use based exposures to human receptors. Thus, the overall summary and recommendations for soil PAHs based on analytical results from the 2009 sampling are as follows:

- A total of 18 samples were collected and analyzed for the specific PAH compounds identified as COCs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene).
- Table 3-1 includes both instrument detection limits reported as the method detection limits (MDLs) and the method report limit (RL). Typically, RLs are approximately an order of magnitude higher than the MDLs. In addition, all of the soil samples were diluted by a factor of five. Therefore, the reported RLs and MDL is five times higher than the actual instrument detection limits. None of the normal samples have detections above criteria, and only one duplicate sample had low levels of two PAH constituents, which were below the industrial CAOs and residential RSLs.
- PAHs were not detected in the upper 2 feet of soil in any of the 18 samples collected during the June 2009 sampling event, including in samples collected from previous high-detection areas (Table 3-1 and Figure 1-8). The only sample that had detectable PAHs was in a field duplicate sample, A22FD(2.0)-060309 from location A22 had concentrations slightly above MDL levels for benzo(a)anthracene (0.48 mg/kg) and benzo(b)fluoranthene (0.55 mg/kg); the normal sample (JM04-A22(2.0)-060309) did not have any detectable levels for these COCs. The BEQ values in this duplicate sample (based on a TEF of 0.1) for benzo(a)anthracene is 0.048 mg/kg and benzo(b)fluoranthene is 0.055 mg/kg. Therefore, the revised residential RSLs for these specific PAHs of 0.15 mg/kg each was not exceeded in this duplicate sample. The absence of detectable levels in the normal sample indicates an uncertainty associated with presence and levels of the PAHs in this duplicate sample.
- The MDLs included in Form 1s in Appendix A ranged between 0.13 UJ mg/kg to 0.3 UJ mg/kg for various PAHs. The MDLs are slightly higher than residential RSL value of 0.015 mg/kg for benzo(a)pyrene. The MDLs are based on a dilution factor of five to account for the five times dilution used by the analytical laboratory.
- The PAH results are summarized on Table 3-1 and sample locations are illustrated on Figure 2-2. Figure 3-1 presents the June 2009 sampling results for PAHs, which were below detection limits in all samples. The absence of PAH concentrations in site soils previously reported during the RFI could be attributable to low levels of PAHs in

gasoline products, PAHs degradation over time. The PAHs from source materials tend to degrade with time as a result of exposure to sun, air, bacteria, and other degrading agents (photo-oxidation and biological degradation).

- The analytical data collected during the RFI (Baker, 1997) are more than 10 years old and concentrations from these historical data no longer appear to represent current site conditions, as indicated by the 2009 data collected from the same locations (Figure 3-1).As can be noted from Table 3-1 and Figure 3-1, the areas with the previous highest detected concentration no longer have detectable PAHs. The PAHs in surface soil have a half-life between 17 to 57 days (Howard, 1991), the range represented by naphthalene and benzo(a)pyrene, respectively. Considering the many number of years passed between the potential release and sampling in 2009, the PAHs are likely below detectable concentration levels. This is observed in site soil samples, by absence of detectable levels of PAHs.
- Because current site concentration levels are below detectable levels (e.g., less than the residential RBC), site soils no longer have PAHs at detectable levels. The rationale for absence of PAHs in soils could be from degradation of PAHs in the surface soils, as previously described. Therefore, PAHs are no longer considered site contaminants in soil. In the absence of significant risks associated with PAHs in site soils, no further actions are needed to address the PAHs at SWMUs 7/8.

3.2 Arsenic

A total of 72 samples were collected and analyzed for arsenic. Arsenic was detected in 69 of the 72 samples at concentrations ranging from 0.81J (C2) to 4.3 mg/kg (B23). Of the 69 samples collected, arsenic was detected above the revised CAO of 3.81 mg/kg in only two borings: B23, and B26. Both of these are located outside the recommended areas for excavation in the 2005 CMS report. Arsenic results are summarized on Table 3-1 and Figure 3-2 highlights the sample locations where arsenic exceeded the revised CAO of 3.81 mg/kg.

Baker developed a CAO for arsenic based on a statistical estimate using the analytical results from 21 "background" surface soil samples collected in areas that exhibited limited disturbance as a result of Navy operations. Areas of "limited disturbance" were defined by the presence of native flora and fauna (Baker, 2006). The samples collected by Baker had arsenic concentrations ranging between non-detect and 3.4 mg/kg (Baker, 1997 and 2005). The surface soil arsenic in background samples ranged between 0.21J mg/kg to 2.5J mg/kg, and the estimated upper bound concentration was 2.65 mg/kg (Baker, 2006). The RFI and CMS reports used to 2.65 mg/kg as the representative background value, and it was also the CAO for arsenic. During the recent sampling work performed by AGVIQ-CH2M HILL (72 samples versus 21 samples), arsenic concentrations ranged from 0.81J to 4.3 mg/kg. AGVIQ-CH2M HILL calculated the average and median arsenic concentrations to be 1.9 mg/kg and 1.8 mg/kg, respectively. These values are compared against the revised CAO of 3.81 mg/kg for industrial land use.

Published reports indicated that arsenic is a common naturally occurring element in soil on the island of Puerto Rico. A 2003 study indicated that arsenic occurs in soil on the island of Puerto Rico at concentrations ranging from 1 to 22 mg/kg (Agency for Toxic Substances and

Disease Registry, 2003). Arsenic is not a contaminant of fuel oils such as those formerly used at the TWFF, and no other metals were identified in Baker's work as a contaminant of concern.

Based on the limited test results used by Baker to calculate the CAO for arsenic, the fact that arsenic is a naturally occurring element in soil, and the evaluation of recent test results, AGVIQ-CH2M HILL elected to estimate the statistical upper bound concentration values for comparison against CAO values using the larger data set to determine if soil excavation is necessary to remove arsenic.

For the evaluation, AGVIQ-CH2M HILL compared the background sample results from the CMS against those obtained in June 2009. Arsenic results for soil within the TWFF were estimated for the upper-bound estimate of the mean (e.g., upper-bound confident limits at 95 percent [UCL95%]), and these values were compared against the UCL95% mean of the background arsenic to statistically evaluate whether arsenic is of natural origin or was introduced as a result of past naval activities. At locations where the UCL 95% for TWFF exceeded both UCL 95% background levels of 2.65 mg/kg and the 3.81 mg/kg arsenic revised CAO, excavation will be necessary to remove the arsenic-impacted soil. However, if UCL95% values were below the revised CAO (also a statistically estimated value), excavation is not required.

The statistical upper bound estimate of the mean (UCL95% values) for site data groups from soil Areas A, B, and C were compared against the background values identified as the revised CAO value of 3.81 mg/kg. Also the combined data from Areas A, B, and C were plotted on an X-Y plot and all data when Log-transformed were normal in distribution, as presented in Figure 3-4, which indicates that the samples represent the same statistical data population. Additionally, comparison of the mean values and UCL95% values between data sets indicated similar distribution among the various site data sets. Therefore, the data appear to represent a similar data population between the three data sets. Appendix B contains the detailed output sheets from the UCL calculations.

The evaluation of the arsenic data included in this CMS addendum indicates the following:

- The detected concentrations in site soil indicated a range between 0.81J mg/kg to 4.3 mg/kg. Typically, larger data sets for naturally occurring inorganic chemicals such as the soil delineation data set, which includes 72 sample locations, will have a greater variation and wider distribution in concentration ranges, typical of larger data sets.
- The maximum detected concentration (4.3 mg/kg in location B23) is adjacent to a roadway and away from former tank areas; the second highest concentration (detection of 4.1 mg/kg in location B26) is in a separate area on the northern end of Area B. Both samples are separated by several samples with low arsenic levels. Based on the June 2009 analytical results, the detected arsenic is randomly distributed across the site (Figure 3-2).
- The highest levels of arsenic are detected in samples located outside of the CMS designated source areas identified for excavation (indicated as Areas A, B, and C on Figure 3-2).

- Overall distribution of arsenic across the three areas of concern is random and does not indicate a distinct distribution pattern; this distribution is most likely representative of soil mineralogy of the area.
- The statistical estimation of the arsenic data calculated separately for Areas A, B, and C has a UCL95% ranging between 1.9 to 2.5 mg/kg (Table 3-2).
- The arsenic distribution is similar among the majority of samples collected across the site, with no elevated or "source" area. Therefore, detected arsenic appears to be related to the natural soil variability and mineralogy and does not indicate a site-specific release.
- A statistical comparison of the site data to background data was performed using the Wilcoxon Ran Sum (WRS) test, where the background data compared against site data were divided into four groups: All Data, Area A, Area B, and Area C. As noted on the table in Appendix B, the comparison results of site data against the background data indicated that the data sets for All Data, Area A, and Area B are not statistically different from background levels. However, Area C is statistically different from the background data set, based on the WRS test. Area C could be statistically different because the data set has the smallest number of samples (n-14) and three samples had concentrations above the background maximum. However, the site maximum detected concentration is not in this data group. Overall detected concentration levels are close in range to all other data sets, as indicated by the combined data set, All Data, being similar to the background data set. Therefore, arsenic is not identified as a final COC based on these statistical comparisons.
- The Q-Q plots of both normal and lognormal data presented in Figures 3-3 and 3-4 estimate correlation coefficient values (R2) of 0.914 (normal) and 0.987 (lognormal), which are substantially greater than 0.5. These R2 values indicate the arsenic data are well correlated between various samples and do not indicate a skewed distribution that is typical of site-specific releases.
- The maximum detected arsenic concentration of 4.3 mg/kg is not identified as a "hot spot," because it is below three times the target revised CAO value of 11.4 mg/kg (3.81 mg/kg * 3). Therefore, no extremely elevated area is identified for arsenic at SWMU 7/8.
- The revised CAO selected for arsenic was based on the industrial land use based protective level for arsenic of 3.81 mg/kg. The current comparable statistical (UCL95%) value for arsenic is 2.5 mg/kg. The site arsenic levels are comparable to background level of 2.65 mg/kg and do not exceed the surface soil revised CAO of 3.81 mg/kg for industrial land use.

Therefore, corrective actions are not recommended for site soils to address the arsenic that was previously identified as a COC. It is no longer considered as COC because of the site-wide concentration levels being similar to background levels and also below levels protective of human health.

Table 3-1
Soil Delineation Analytical Results at SWMU 7/8 (June 2009)
Roosevelt Roads Naval Station, Puerto Rico

Station ID	Sample ID	Sample Depth	Arsenic	Benzo (a) Anthracene		Benzo (a) Pyrene		Benzo (b) Fluoranthene		Indeno (1,2,3-cd) Pyrene	
		feet	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	*CAOs in Surface Soil (mg/kg)**		*3.81*	*7.8*		*7.3*		*7.8*		*7.8*	
	RSL for Residential (Unrestricted) Use (mg/kg)		*3.81*	*0.15*		*0.015*		*0.15*		*0.15*	
				RL	*MDL*	*RL*	*MDL*	*RL*	*MDL*	*RL*	*MDL*
A1	JM04-A1(2.0)-060309	0 - 2	1.4J	---	---	---	---	---	---	---	---
A2	JM04-A2(2.0)-060309	0 - 2	1.6J	---	---	---	---	---	---	---	---
A3	NA	---	---	---	---	---	---	---	---	---	---
A4	NA	---	---	---	---	---	---	---	---	---	---
A5	NA	---	---	---	---	---	---	---	---	---	---
A6	JM04-A6(2.0)-060309	0 - 2	1.3J	---	---	---	---	---	---	---	---
A7	JM04-A7(2.0)-060309	0 - 2	1.1J	---	---	---	---	---	---	---	---
A8	JM04-A8(2.0)-060309	0 - 2	2.2J	---	---	---	---	---	---	---	---
A9	JM04-A9(2.0)-060409	0 - 2	1.4J	---	---	---	---	---	---	---	---
A10	JM04-A10(2.0)-060409	0 - 2	2.5U	---	---	---	---	---	---	---	---
A11	JM04-A11(2.0)-060309	0 - 2	1.7J	---	---	---	---	---	---	---	---
A12	JM04-A12a(2.0)-060309	0 - 2	1.6J	---	---	---	---	---	---	---	---
A13	NA	---	---	---	---	---	---	---	---	---	---
A14	JM04-A14(2.0)-060309	0 - 2	1J	2.2UJ	0.24UJ	2.2UJ	0.15UJ	2.2UJ	0.21UJ	2.2UJ	0.3UJ
A15	JM04-A15(2.0)-060209	0 - 2	1.7J	2.2UJ	0.24UJ	2.2UJ	0.15UJ	2.2UJ	0.21UJ	2.2UJ	0.31UJ
A16	JM04-A16(2.0)-060209	0 - 2	1.6J	---	---	---	---	---	---	---	---
A17	JM04-A17(2.0)-060409	0 - 2	2J	---	---	---	---	---	---	---	---
A18	JM04-A18(2.0)-060409	0 - 2	2.3J	---	---	---	---	---	---	---	---
A19	JM04-A19(2.0)-060309	0 - 2	2.4J	---	---	---	---	---	---	---	---
A20	JM04-A20(2.0)-060309	0 - 2	2.4J	---	---	---	---	---	---	---	---
A21	NA	---	---	---	---	---	---	---	---	---	---
A22	JM04-A22(2.0)-060309	0 - 2	1.7J	2.0UJ	0.22UJ	2.0UJ	0.14UJ**	2.0UJ	0.19UJ**	2.0UJ	0.27UJ
A23	JM04-A23(2.0)-060309	0 - 2	2.1J	2.2UJ	0.24UJ	2.2UJ	0.15UJ	2.2UJ	0.21UJ	2.2UJ	0.3UJ
A24	JM04-A24(2.0)-060209	0 - 2	1.2J	Asphalt Present in Sample							
A25	JM04-A25(2.0)-060209	0 - 2	2.4	---	---	---	---	---	---	---	---
A26	JM04-A26(2.0)-060409	0 - 2	2.1J	---	---	---	---	---	---	---	---
A27	JM04-A27(2.0)-060409	0 - 2	1.2J	---	---	---	---	---	---	---	---
A28	JM04-A28(2.0)-060209	0 - 2	1.9J	2.4UJ	0.26UJ	2.4UJ	0.17UJ	2.4UJ	0.23UJ	2.4UJ	0.34UJ
A29	JM04-A29(2.0)-060209	0 - 2	1.7J	2.1UJ	0.23UJ	2.1UJ	0.15UJ	2.1UJ	0.20UJ	2.1UJ	0.29UJ
A30	JM04-A30(2.0)-060209	0 - 2	3J	---	---	---	---	---	---	---	---
A31	JM04-A31(2.0)-060209	0 - 2	1.6J	---	---	---	---	---	---	---	---
A32	JM04-A32(2.0)-060209	0 - 2	1.7J	---	---	---	---	---	---	---	---
A33	JM04-A33(2.0)-060209	0 - 2	2.4J	---	---	---	---	---	---	---	---
A34	JM04-A34(2.0)-060209	0 - 2	1.4J	---	---	---	---	---	---	---	---
A35	JM04-A35a(2.0)-060209	0 - 2	1.9J	2.0UJ	0.22UJ	2.0UJ	0.14UJ	2.0UJ	0.19UJ	2.0UJ	0.28UJ
A36	JM04-A36(2.0)-060209	0 - 2	1.8J	---	---	---	---	---	---	---	---
A37	JM04-A37(2.0)-060209	0 - 2	1.5J	---	---	---	---	---	---	---	---
A38	NA	---	---	---	---	---	---	---	---	---	---

Table 3-1
Soil Delineation Analytical Results at SWMU 7/8 (June 2009)
Roosevelt Roads Naval Station, Puerto Rico

Station ID	Sample ID	Sample Depth	Arsenic	Benzo (a) Anthracene		Benzo (a) Pyrene		Benzo (b) Fluoranthene		Indeno (1,2,3-cd) Pyrene	
		feet	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	*CAOs in Surface Soil (mg/kg)**		*3.81*	*7.8*		*7.3*		*7.8*		*7.8*	
	RSL for Residential (Unrestricted) Use (mg/kg)		*3.81*	*0.15*		*0.015*		*0.15*		*0.15*	
				RL	*MDL*	*RL*	*MDL*	*RL*	*MDL*	*RL*	*MDL*
A39	JM04-A39(2.0)-060209	0 - 2	**1.8J**	2.4UJ	0.33UJ	2.4UJ	0.21UJ	2.4UJ	0.29UJ	2.4UJ	0.42UJ
A40	JM04-A40(2.0)-060209	0 - 2	**1.7J**	1.9UJ	0.21UJ	1.9UJ	0.13UJ	1.9UJ	0.18UJ	1.9UJ	0.26UJ
A41	JM04-A41(2.0)-060209	0 - 2	**0.95J**	1.8UJ	0.20UJ	1.8UJ	0.12UJ	1.8UJ	0.17UJ	1.8UJ	0.25UJ
A42	NA	---	---	---	---	---	---	---	---	---	---
A43	NA	---	---	---	---	---	---	---	---	---	---
A44	NA	---	---	---	---	---	---	---	---	---	---
A45	NA	---	---	---	---	---	---	---	---	---	---
B1	JM04-B1(2.0)-060409	0 - 2	2.6U	2.2UJ	0.24UJ	2.2UJ	0.15UJ	2.2UJ	0.21UJ	2.2UJ	0.30UJ
B2	JM04-B2(2.0)-060409	0 - 2	**1.7J**	2.1UJ	0.23UJ	2.1UJ	0.15UJ	2.1UJ	0.20UJ	2.1UJ	0.30UJ
B3	JM04-B3(2.0)-060409	0 - 2	**1.8J**	2.2UJ	0.24UJ	2.2UJ	0.15UJ	2.2UJ	0.21UJ	2.2UJ	0.31UJ
B4	JM04-B4(2.0)-060409	0 - 2	**1.3J**	2.0UJ	0.22UJ	2.0UJ	0.14UJ	2.0UJ	0.19UJ	2.0UJ	0.27UJ
B5	JM04-B5(2.0)-060409	0 - 2	**1.8J**	2.0UJ	0.22UJ	2.0UJ	0.14UJ	2.0UJ	0.19UJ	2.0UJ	0.28UJ
B6	JM04-B6(2.0)-060409	0 - 2	**1.9J**	2.2UJ	0.24UJ	2.2UJ	0.15UJ	2.2UJ	0.20UJ	2.2UJ	0.30UJ
B7	JM04-B7(2.0)-060409	0 - 2	**2.2J**	Asphalt Present in Sample							
B8	JM04-B8(2.0)-060409	0 - 2	**1.2J**	---	---	---	---	---	---	---	---
B9	JM04-B9(2.0)-060409	0 - 2	**2.7**	---	---	---	---	---	---	---	---
B10	JM04-B10(2.0)-060409	0 - 2	**2.1J**	---	---	---	---	---	---	---	---
B11	JM04-B11(2.0)-060409	0 - 2	**1.5J**	---	---	---	---	---	---	---	---
B12	JM04-B12(2.0)-060409	0 - 2	**2.1J**	---	---	---	---	---	---	---	---
B13	JM04-B13(2.0)-060409	0 - 2	2.3U	---	---	---	---	---	---	---	---
B14	JM04-B14(2.0)-060409	0 - 2	**2.8**	---	---	---	---	---	---	---	---
B15	JM04-B15(2.0)-060409	0 - 2	**1.3J**	---	---	---	---	---	---	---	---
B16	NA	---	---	---	---	---	---	---	---	---	---
B17	NA	---	---	---	---	---	---	---	---	---	---
B18	JM04-B18(2.0)-060409	0 - 2	**1.5J**	---	---	---	---	---	---	---	---
B19	JM04-B19(2.0)-060409	0 - 2	**1.8J**	---	---	---	---	---	---	---	---
B20	NA	---	---	---	---	---	---	---	---	---	---
B21	NA	---	---	---	---	---	---	---	---	---	---
B22	JM04-B22(2.0)-060409	0 - 2	**1.5J**	---	---	---	---	---	---	---	---
B23	JM04-B23(2.0)-060409	0 - 2	**4.3**	---	---	---	---	---	---	---	---
B24	JM04-B24(2.0)-060409	0 - 2	**1.5J**	2.2UJ	0.24UJ	2.2UJ	0.15UJ	2.2UJ	0.21UJ	2.2UJ	0.30UJ
B25	JM04-B25(2.0)-060409	0 - 2	**1.2J**	1.9UJ	0.21UJ	1.9UJ	0.13UJ	1.9UJ	0.18UJ	1.9UJ	0.26UJ
B26	JM04-B26(2.0)-060409	0 - 2	**4.1**	2.3UJ	0.25UJ	2.3UJ	0.16UJ	2.3UJ	0.22UJ	2.3UJ	0.31UJ
B27	JM04-B27(2.0)-060409	0 - 2	**1.9J**	2.0UJ	0.21UJ	2.0UJ	0.13UJ	2.0UJ	0.18UJ	2.0UJ	0.27UJ
C1	JM04-C1(2.0)-060109	0 - 2	**2.2J**	---	---	---	---	---	---	---	---
C2	JM04-C2(2.0)-060109	0 - 2	**0.81J**	---	---	---	---	---	---	---	---
C3	JM04-C3(2.0)-060109	0 - 2	**2.8**	---	---	---	---	---	---	---	---
C4	NA	---	---	---	---	---	---	---	---	---	---

Table 3-1
Soil Delineation Analytical Results at SWMU 7/8 (June 2009)
Roosevelt Roads Naval Station, Puerto Rico

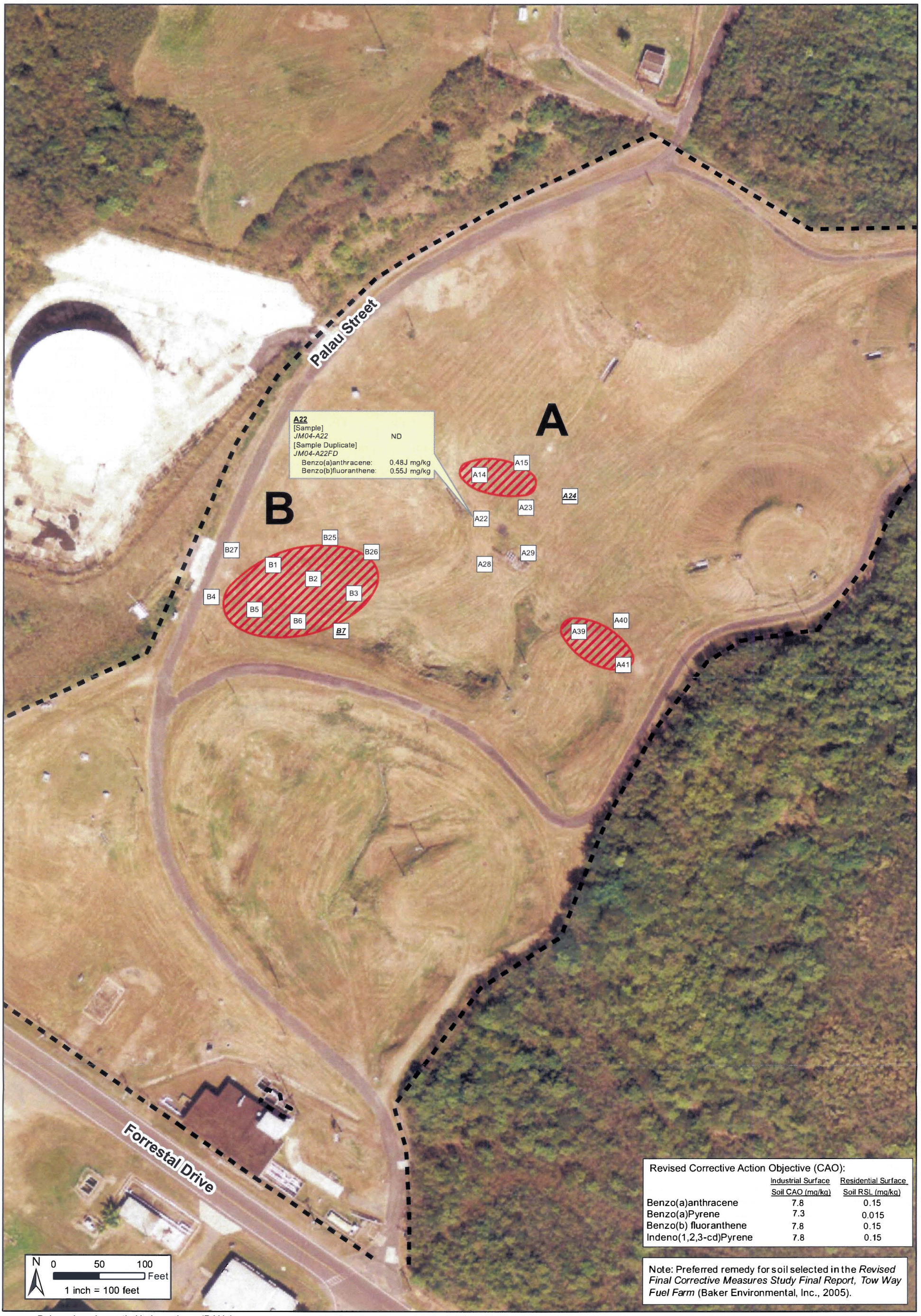
Station ID	Sample ID	Sample Depth	Arsenic	Benzo (a) Anthracene		Benzo (a) Pyrene		Benzo (b) Fluoranthene		Indeno (1,2,3-cd) Pyrene	
		feet	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	*CAOs in Surface Soil (mg/kg)**		*3.81*	*7.8*		*7.3*		*7.8*		*7.8*	
	RSL for Residential (Unrestricted) Use (mg/kg)		*3.81*	*0.15*		*0.015*		*0.15*		*0.15*	
				RL	*MDL*	*RL*	*MDL*	*RL*	*MDL*	*RL*	*MDL*
C5	JM04-C5(2.0)-060109	0 - 2	**1.9J**	---	---	---	---	---	---	---	---
C6	JM04-C6(2.0)-060109	0 - 2	**2.3**	---	---	---	---	---	---	---	---
C7	JM04-C7a(2.0)-060109	0 - 2	**3.2**	---	---	---	---	---	---	---	---
C8	JM04-C8a(2.0)-060109	0 - 2	**2J**	---	---	---	---	---	---	---	---
C9	JM04-C9(2.0)-060109	0 - 2	**3**	---	---	---	---	---	---	---	---
C10	JM04-C10(2.0)-060109	0 - 2	**1.7J**	---	---	---	---	---	---	---	---
C11	JM04-C11(2.0)-060109	0 - 2	**1.7J**	---	---	---	---	---	---	---	---
C12	JM04-C12(2.0)-060109	0 - 2	**2.9**	---	---	---	---	---	---	---	---
C13	JM04-C13a(2.0)-060109	0 - 2	**1.6J**	---	---	---	---	---	---	---	---
C14	JM04-C14(2.0)-060109	0 - 2	**1.8J**	---	---	---	---	---	---	---	---
C15	JM04-C15(2.0)-060109	0 - 2	**2.5J**	---	---	---	---	---	---	---	---
C16	NA	---	---	---	---	---	---	---	---	---	---

--- = No data collected
NA = not accessible
RL = reporting limit
MDL = method detection limit
J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.
U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
UJ = The analyte was below the reported sample quantitation limit. However, the reported value is approximate.
mg/kg = Milligrams per Kilogram
ug/kg = Micrograms per Kilogram
Bold indicates the analyte was detected
Shading indicates the analyte exceeded screening criteria
* Screening Levels obtained from "Revised Final Corrective Measures Study Final Report", November 22, 2005 (Table 1-1). PAHs were not detected in any samples, thus no CAO exceedences.
** - only duplicate sample JM04-A22FD(2.0)-060309 had detecion of two PAHs, benzo(a)anthracene and benzo(b)fluoranthene at 0.48 mg/kg and 0.55 mg/kg, respectively. Detections are below CAOs.
MDLs are based on 5 times dilution of the native sample, thus final MDL value listed in the table is 5 times higher than the intstrument detection limit.
MDLs are an order of magnitude lower than RLs, and no detectable PAHs are present in site soils. Thus no PAHs are present at detectable levels in site soils.

Table 3-2
Data Summary per Area and Combined Data at SWMUs 7/8, Areas A, B and C
Roosevelt Roads Naval Station, Puerto Rico

Area	N of Samples	N of Detects	Min	Max	Mean	Data Distribution	UCL95%	Statistic
Area A	35	34	0.95	3	1.8	Lognormal	1.9	95% KM (t) UCL
Area B	23	21	1.2	4.3	2.0	Nonparametric	2.2	95% KM (BCA) UCL
Area C	14	14	0.81	3.2	2.2	Normal	2.5	Use 95% Student's-t UCL
All (A,B&C)	72	69	0.81	4.3	1.94	Lognormal	2.0	95% KM (BCA) UCL

Note:
The estimated UCL95% levels are less than the target CAO of 2.65 mg/kg.



Revised Corrective Action Objective (CAO):

	Industrial Surface Soil CAO (mg/kg)	Residential Surface Soil RSL (mg/kg)
Benzo(a)anthracene	7.8	0.15
Benzo(a)Pyrene	7.3	0.015
Benzo(b) fluoranthene	7.8	0.15
Indeno(1,2,3-cd)Pyrene	7.8	0.15

Note: Preferred remedy for soil selected in the *Revised Final Corrective Measures Study Final Report, Tow Way Fuel Farm* (Baker Environmental, Inc., 2005).

Polynuclear Aromatic Hydrocarbons (PAHs) Soil Delineation Sampling Point

A22 Soil sample with concentrations (in milligrams per kilgram [mg/kg]) below detection limits

A22 Soil sample with concentrations (in milligrams per kilgram [mg/kg]) above CAOs

Fence

PAH Excavation Area (See Note)

PAHs = Benzo(a)anthracene
Benzo(a)Pyrene
Benzo(a) fluoranthene
Benzo(1,2,3-cd)Pyrene
J = Estimated Detected Concentration
ND = Not Detected

A24 = Asphalt present in soil sample

FIGURE 3-1
Soil Delineation Sample Locations for PAHs
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

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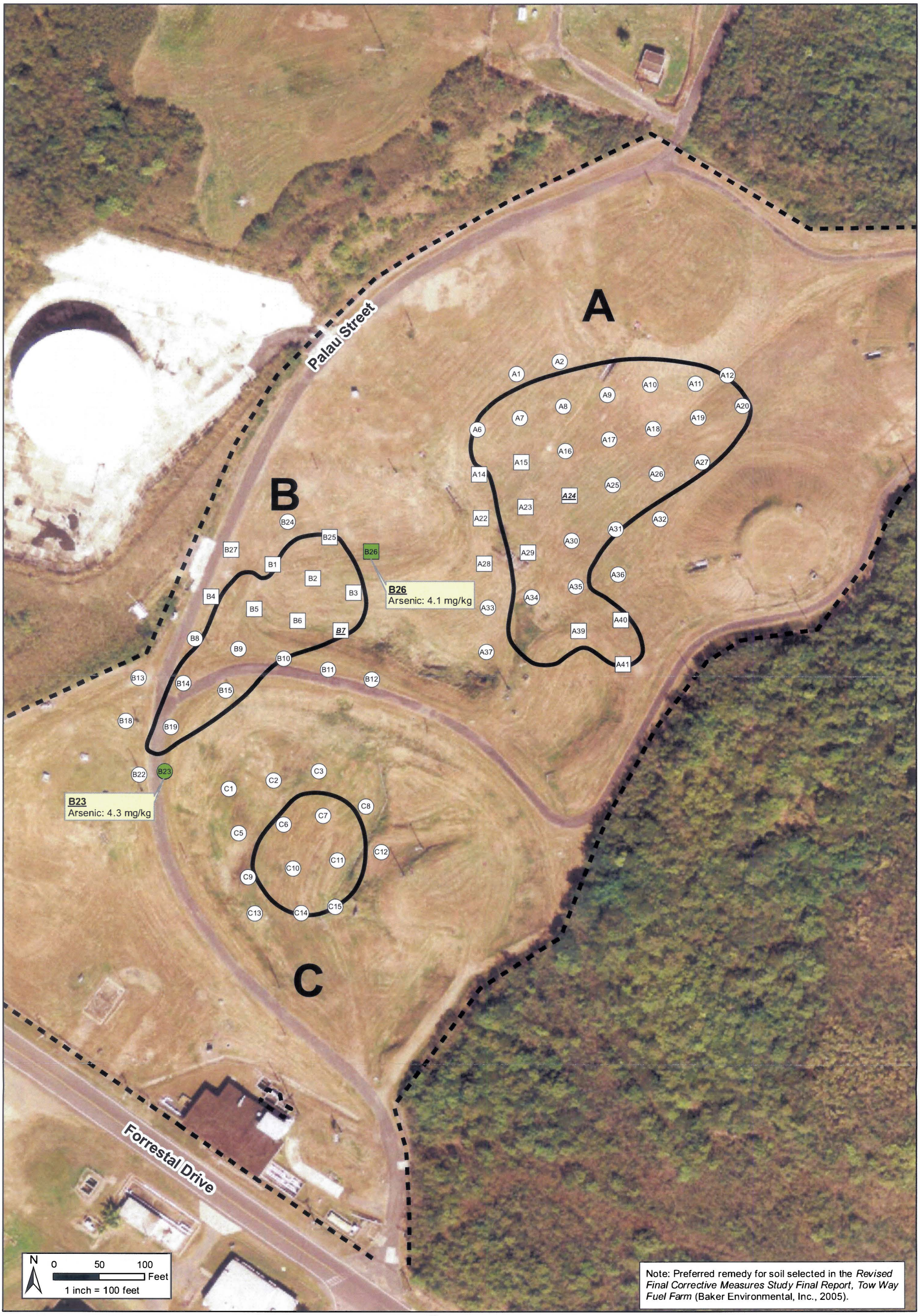

Soil Delineation Sampling Point

- Arsenic
- Arsenic and Polynuclear Aromatic Hydrocarbons (PAHs)
- Fence
- Assumed Arsenic Impacted Soil Area (See Note)

B14 = Soil sample with concentrations (in milligrams per kilogram [mg/kg]) above the revised Corrective Action Objective (CAO):
Arsenic: 3.81 mg/kg
J = Estimated Detected Concentration

B23 Arsenic: 4.3 mg/kg

A24 = Asphalt present in soil sample. Sample only tested for arsenic.

FIGURE 3-2
Soil Delineation Sample Locations that Exceeded the Arsenic CAO
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

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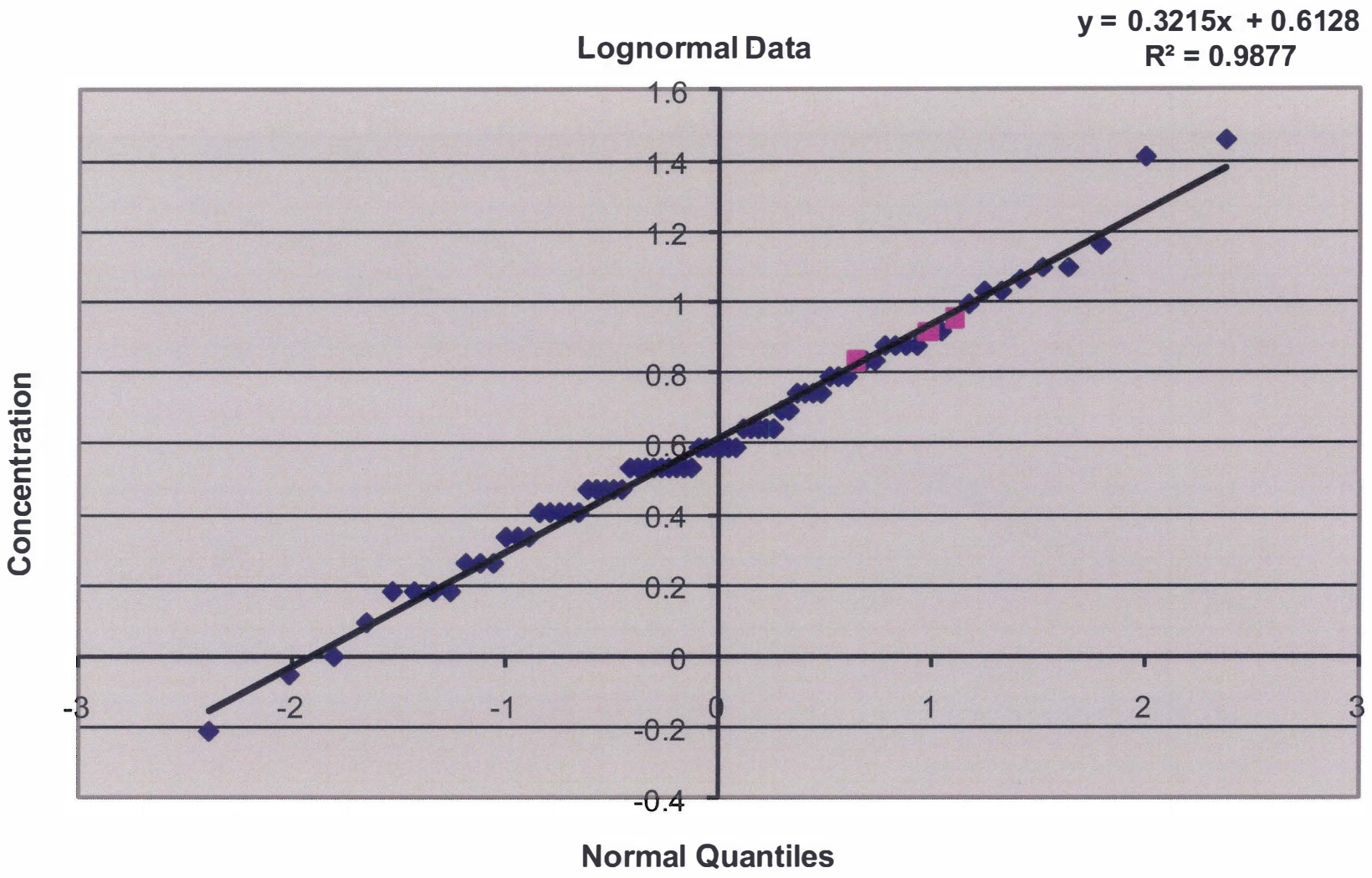

FIGURE 3-3
Arsenic Distribution Plot Across SWMU 7/8: Lognormal Data
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

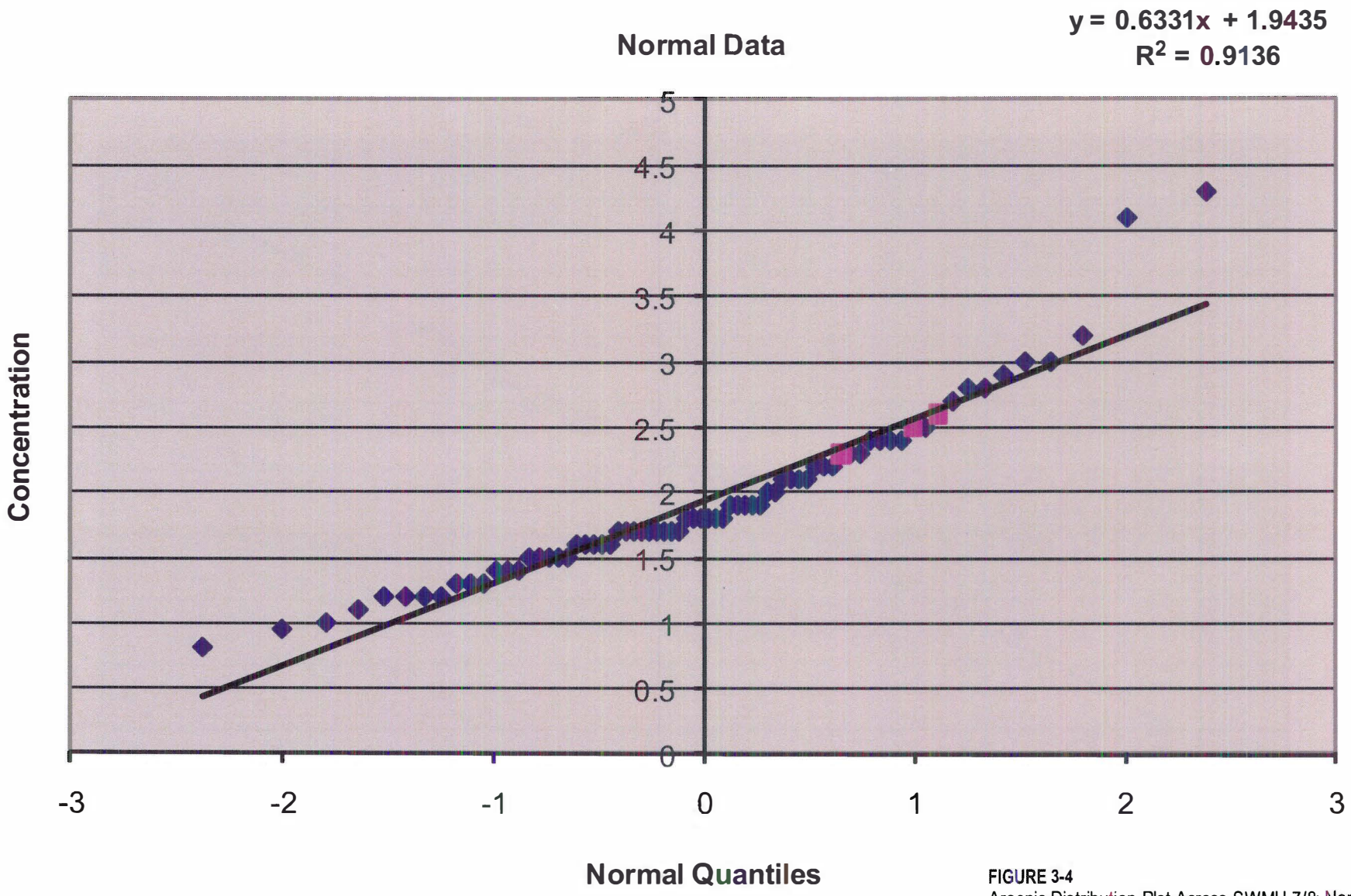

FIGURE 3-4
Arsenic Distribution Plot Across SWMU 7/8: Normal Data
Tow Way Fuel Farm
Naval Station Roosevelt Roads, Puerto Rico

4.0 Findings and Recommendations

4.1 Findings

Based on the field and analytical data collected from the SWMUs 7/8 area, the following findings were made:

- PAHs were not detected above detection limits in any of the soil samples, with the exception of low level detections in one duplicate sample. All sample MDLs and RLs are below the industrial CAOs. Under current industrial land use, PAHs do not present an exposure concern for human receptors (i.e., industrial workers). Thus, previously identified PAH concentration levels during the RFI and CMS (Baker, 2005) are no longer occurring at the site. Corrective actions are not recommended for PAHs in surface soil under industrial land use. Overall absence of PAHs indicated that site soils no longer have PAHs above MDLs and RLs.
- Arsenic was detected across the site in 69 out of 72 surface soil samples. However, results of a statistical evaluation indicate the current comparable statistical value (UCL95%) for arsenic is 2.5 mg/kg, is below the background statistical upper limit value of 2.65 mg/kg. Therefore, site arsenic levels are representative of background levels and are below the revised CAO of 3.81 mg/kg.

4.2 Recommendations

Based on the analytical results for the surface soil samples, there is no soil contamination at the site that requires corrective actions under industrial land use. PAH concentrations are below lower DLs, i.e., MDLs that ranged between <0.13 mg/kg and <0.4 mg/kg. The site soil contamination levels do not present human or ecological exposure concern, as explained above. However, because of the DLs that are above residential RSL values of 0.015 mg/kg to 0.15 mg/kg, soils may contain PAHs at levels below the current MDLs, and may be above residential RSLs. Though PAHs were not detected in any of the soil normal samples, because of the elevated MDLs, it may be possible for PAHs to be occurring in soils at low levels between the MDLs and residential CAOs. Therefore, SWMUs 7/8 is recommended for industrial land use with no active remediation, and land use restrictions with LUCs to preclude for a future unrestricted land use due to possible PAHs in site soils above the residential CAOs shown in Table 1-2.

Based on the extensive sampling (72 samples analyzed for arsenic) conducted across the site, detected arsenic is randomly distributed across the site. The distribution patterns indicate absence of specific elevated arsenic concentration areas, and statistical evaluation of the data indicate site arsenic upper-bound concentration limits of the mean estimates to be between 1.9 mg/kg and 2.5 mg/kg, which are below the background level of 2.65 mg/kg and also below the revised CAO target level of 3.81 mg/kg. No single detection is indicative of extremely elevated values, as the maximum detected concentration at 4.3 mg/kg is below

the levels indicative of any 'hot spot' area, and site-wide arsenic levels are similar to the background representative concentration levels of 2.65 mg/kg. Therefore, the detected arsenic levels at SWMUs 7/8 are considered naturally occurring within the surface soil and no further action (NFA) is recommended for arsenic in site soils.

As presented in Section 3.3, site soil residual concentrations for the two COCs, PAHs and arsenic, are either below DLs or similar to background levels. Therefore, NFA is recommended for SWMUs 7/8 soils under industrial land use, as soils do not pose exposure related risks to human health under industrial use scenario or the environment. However, because of the MDLs for PAHs that are higher than residential CAOs, the site is recommended for continued industrial land use with LUCs precluding future unrestricted land use based on possible PAHs in site soils above the residential CAOs shown in Table 1-2.

The existing LUCs are included as part of the corrective action to prevent the unrestricted land use for soils. Although groundwater is not addressed as part of this soil CMS Addendum report, the LUCs also address the unintended exposure to groundwater. Existing LUCs are described in the Quitclaim Deed for CDR Parcel 2 (SWMU 55) signed by the Navy and the LRA on December 20, 2011. Current LUCs, including restricted access to the SWMUs 7/8 area through security fencing, will be maintained. The LUCs will be included in any lease or transfer deed. If development other than industrial use (i.e., residential or per the April 2010 amended Reuse Plan) is proposed, the new owner will be required to work with the PREQB and EPA to establish any additional investigation, risk assessment, and/or cleanup activities. If the property owner wishes to remove the LUC from the deed in the future, it will be the responsibility of the property owner to demonstrate that groundwater meets all state and federal MCLs, and to obtain approval from the Navy, EPA, and PREQB prior to LUC removal.

Regulatory comments and associated Navy responses associated with this CMS Addendum are provided in Appendix E.

5.0 References

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